

# OSHA 10-HOUR VOLUNTARY COMPLIANCE COURSE

Outline  
Developed  
by the  
State of Colorado  
Office of Risk Management

**OSHA 10-Hour Voluntary Compliance Course  
CLASS SCHEDULE**

**Day 1**

Introduction and Sign-In 8:00 - 8:15 a.m.

Introduction to OSHA Standards 8:15 - 9:15 a.m.

BREAK 9:15 - 9:30 a.m.

Walking and Working Surfaces 9:30 - 10:30 a.m.

Means of Egress/Fire Protection 10:30 - 11:30 a.m.

LUNCH 11:30 - 12:30 a.m.

Hazardous Materials 12:30 - 1:30 a.m.

Material Handling 1:30 - 2:30 p.m.

BREAK 2:30 - 2:45 p.m.

Hazard Communication 2:45 - 3:45 p.m.

**Day 2**

Introduction and Sign-In 8:00 - 8:15 a.m.

Personal Protective Equipment 8:15 - 9:15 a.m.

BREAK 9:15 - 9:30 a.m.

Electrical 9:30 - 10:30 a.m.

Recordkeeping 10:30 - 11:30 a.m.

LUNCH 11:30 - 12:30 a.m.

Machine Guarding 12:30 - 1:30 a.m.

Lockout/Tagout 1:30 - 2:30 p.m.

BREAK 2:30 - 2:45 p.m.

Welding 2:45 - 3:45 p.m.

# **Introduction to the OSH Act and OSHA Standards**

## **I. Background and General Provisions of the OSH Act (PL 91-596)**

### **A. Origin of the OSH Act and OSHA Standards**

1. Consensus standards - ANSI, NFPA
2. Proprietary standards - specific industries
3. Prior Legislation - federal standards

### **B. Passage of the OSH Act - 1970**

1. No uniform and comprehensive protection against workplace safety and health hazards
2. Workplace accident statistics in 1970:
  - More than 14,000 job-related deaths
  - Nearly 2½ million workers disabled
  - Ten times more lost time than strikes
  - 300,000 occupational disease cases

### **C. Intent of the Act**

1. *“...to assure so far as possible every working man and woman in the Nation safe and healthful working conditions and to preserve our human resources.”*
2. Created OSHA to develop, implement and enforce safety standards

### **D. Major Provisions of the OSHA Act:**

- Definitions and applicability
- Employer/employee duties
- Standards
- Inspections and Recordkeeping
- Enforcement
- Judicial Review (U.S. Court of Appeals)
- Imminent Danger (U.S. District Courts)

## **II. General Duty Clause - PL 91-596, 5(a)(1)**

### **A. Non-specific protection**

- B. Employer responsibilities
- C. Use and limitations

## **The General Duty Clause**

**Public Law 91-596 December 29, 1970**  
**DUTIES**

Sec. 5. (a) Each employer—

(1) shall furnish to each of his employees employment and a place of employment which are free from recognized hazards that are causing or likely to cause death or serious physical harm to his employees

### **III. Types of Standards, Format of 29 CFR 1900**

#### **A. Horizontal Standards**

- 1. Apply to any employer
- 2. Also called “general” standards

#### **B. Vertical Standards**

- 1. Apply to a particular industry or condition
- 2. Also called “particular” standards

#### **C. OSHA Regulations - 29 CFR 1900**

- 1. “Parts” of 29 CFR 1900 are regulations:
  - 1902 - State plans
  - 1903 - Inspections, citations, proposed penalties
  - 1904 - Recordkeeping requirements
  - 1905 - Variances
  - 1908 - Consultation agreements
  - 1910 - Occupational safety and health standards
- 2. “Subparts” of 29 CFR 1910:
  - Subpart D - Walking and Working Surfaces
  - Subpart E - Means of Egress
  - Subpart G - Occupational Health and Environmental Control

- Subpart H - Hazardous Materials
- Subpart I - Personal Protective Equipment
- Subpart L - Fire Protection
- Subpart N - Materials Handling and Storage

3. 29 CFR 1910 Parts, Subparts, Sections and Subsections

- Organizes all Federal Regulations by paragraph
- Capitol letter is used instead of italicized letter in fourth set of parentheses for standards promulgated after 1979.

## Examples of CFR Numbering System

### REGULATIONS PROMULGATED BEFORE 1979:

<u>Title</u>	<u>Code of Federal Regs.</u>	<u>Part</u>	<u>Section</u>	<u>Subsection</u>	<u>Italics</u>
29	CFR	1910.110		(b)(13)(ii)	(b)(7)(iii)

### REGULATIONS PROMULGATED AFTER 1979:

<u>Title</u>	<u>Code of Federal Regs.</u>	<u>Part</u>	<u>Section</u>	<u>Subsection</u>	<u>Upper Case</u>	<u>Italics</u>
29	CFR	1910.304		(f)(5)(iv)	(F)	(1)

#### IV. OSHA Inspection Procedures

##### A. Inspection priorities

1. Imminent Danger
2. Fatality/Catastrophe
3. Complaints/Referrals
4. Programmed inspections

##### B. Advance Notice

1. Imminent Danger

2. After regular business hours or requiring special preparation
3. To ensure employer and employee representatives are present
4. Advance notice would produce a more thorough or effective inspection
5. Advance notice will be less than 24 hours
6. Employer must inform employee representative or get OSHA to do so

C. Compliance Safety and Health Officer

1. Must present official U.S. Department of Labor photo I.D., serial #
2. Prevent “unreasonable disruption” of employer’s operations during inspection
3. CSHO cannot divulge trade secrets
4. CSHO can get a warrant if employer refuses entry
5. CSHO can use “reasonable investigative techniques” including:
  - Environmental samples
  - Photographs
  - Dosimeters, pumps, badges
6. CSHO must follow all employer’s safety rules, use appropriate clothing and personal protective equipment

D. General Inspection Procedures

1. Opening Conference
2. Employee Participation
3. Walkaround
4. Closing Conference
5. Citation/Notification of Penalty

V. Types of Violations, Penalties, and Abatement

A. Violation Types

1. Serious: fatal or catastrophic accident could occur
2. Other-than-serious: proposed penalty, can be waived or reduced by OSHA
3. Willful: employer knowingly commits violations or knows about hazard but refused to abate it.
4. Criminal Willful: Willful violation resulting in death of employee
5. Repeated - hazardous condition still exists on re-inspection
6. De Minimus - very minor violation - no penalty

B. Penalties

1. Range of penalties - zero to \$70,000 per violation, depending on type of violation
2. Adjustment factors - good faith, history of violations, size of business
3. Egregious cases - “conspicuously bad” - penalties for each violation can add up to total penalty over \$1 million
4. Penalties for specific violations:
  - Serious: mandatory penalty up to \$7000 per violation
  - Willful or Repeated: penalty from \$5000 to \$70,000 for each violation
  - Criminal Willful: jail sentence and/or fines up to \$250,000 for individual and \$500,000 for organization

C. Abatement

1. Abatement period - abatement must begin immediately, be completed by a specified date
2. Employer abatement assistance
3. Failure to abate - Penalty up to \$7000 for each day of violation

# **Walking and Working Surfaces**

## **OSHA Subpart D**

### **I. General Housekeeping/Floor and Wall Openings (1910.22 & 23)**

#### **A. Housekeeping**

1. Clean and orderly and in a sanitary condition
2. Clean and (when possible) dry floors
  - Wet processes require drainage, gratings, mats or raised platforms
3. No protruding nails, splinters, holes or loose boards

#### **B. Aisles and Passageways**

1. Keep clear and in good repair, no obstructions
2. Permanent aisles, passageways appropriately marked
3. “Sufficient safe clearance” in aisles for mechanical equipment

#### **C. Covers and Guardrails**

1. Protect from open pits, tanks, vats, ditches

#### **D. Floor Loading Protection**

1. Floor load ratings must be posted by building owner
2. Usually rated in pounds per square foot
3. Exceeding posted rating is a violation

#### **E. Floor and wall openings and holes**

1. Definitions (all measurements are “least dimension”)
  - Floor hole - between 1" and 12"
  - Floor opening - more than 12"
  - Wall hole - between 1" and 30"
  - Wall opening - At least 18" X 30"



- Standard railing - top rail, mid rail and posts; vertical height 42" from top rail to walking surface, mid rail height 21"
  - Standard toeboard - 4" height, not more than 1/4" clearance above floor
2. Standard railings on all exposed sides of stairs except entrance
  3. Floor openings may be covered or guarded with rails. When uncovered, temporary guardrail or attendant required
  4. Floor holes must be guarded by standard railing with toeboard or floor hole covering. When uncovered, removable standard railing or attendant required
- D. Open-sided floors, platforms, etc.
1. Standard railing required for all open-sided floors or platforms 4 feet higher than adjacent floor or ground level
  2. Toeboard also required whenever:
    - Persons can pass underneath
    - Moving machinery underneath
    - Falling materials could create a hazard for equipment underneath
  3. Runways (elevated walkways) require standard railing on all sides 4 feet or more above floor or ground level. Toeboards required if tools, machine parts or materials used on runway.
  4. Standard railing and toeboard required for all open-sided floors, walkways, platforms, or runways above or next to dangerous equipment, pickling or galvanizing tanks, degreasing units

## II. Stairs (1910.23 & 24)

### A. Handrails and stair rails

1. Definitions:
  - Stair rail: top rail 30" to 34" high
  - Handrail: 30" to 34" high, 3" from wall, no more than 8 feet apart
2. Requirements:
  - Stairways less than 44" wide, both sides enclosed, require at least one

handrail

- Stairways less than 44" wide: one open side, one stair rail on open side
- Stairways less than 44" wide: both sides open, stair rails on each side
- Stairways 44" to 88" wide: handrail on each enclosed side, stair rail on each open side
- Stairways 88" or more wide: handrail on each enclosed side, stair rail on each open side, one intermediate stair rail in the middle

B. Fixed industrial stairs

1. Requirements

- Strong enough to carry 5 times the normal anticipated live load
- Minimum moving concentrated load 1000 pounds
- Minimum width 22"
- Angles between 30° and 50°
- Vertical clearance at least 7 feet
- Landings and platforms at least as wide as the stairs, at least 30" in length, in direction of travel

2. Inspection tips (see handout, p.8)

III. Ladders (1910.25, 26 & 27)

A. Portable ladders

1. Types

- Stepladder: self-supporting, fixed length, flat steps and hinged back
- Single ladder: not self-supporting, fixed length, one section
- Extension ladder: not self-supporting, adjustable length

2. Requirements:

- Maximum stepladder length: 20 feet

- Stepladders require metal spreader or locking device to hold open
- Maximum single ladder length: 30 feet
- Maximum extension ladder length: 60 feet
- Maintained in good condition at all times
- Inspected frequently, defective ladders tagged “Dangerous, Do Not Use” and withdrawn from service for repair or destruction

3. Safety precautions for ladder use:

- Placed with secure footing, lashed, or held in position
- Top of ladder extends 3 feet above top point of support
- One-In-Four Rule (next overhead)
- Always face the ladder when climbing up or down
- Never splice ladders together
- Never use ladders horizontally as scaffolds or work platforms
- Never use top step of stepladder
- Use both hands when climbing up or down
- Never use metal ladders near electrical equipment

B. Fixed ladders

1. Definitions

- Fixed ladder: permanently attached to structure, building or equipment
- Cage: guard fastened to ladder or structure, encircles climbing space of ladder to prevent falls
- Ladder safety device: prevents falls using life belts, friction brakes, sliding attachments
- Landing platform: interrupts free fall, resting place during long climbs

2. Requirements:

- Cages or ladder safety devices required for fixed ladders over 20 feet

in length to a maximum unbroken length of 30 feet.

- Cages must extend at least 42" above the top of a landing, between 7 and 8 feet above base of ladder
- Fixed ladders over 20 feet require landing platforms for each 30 feet when cages are used. When no cage or ladder safety device is provided, platforms every 20 feet
- Preferred pitch 75° to 90° from horizontal, substandard 60° to 75°, pitch in excess of 90° prohibited

#### IV. Scaffolds and Mobile Scaffolds(1910.28 & 29)

##### A. Scaffolds

###### 1. General requirements

- Sound, rigid footing or anchorage, no unstable objects used as support
- Scaffolds and components capable of supporting four times maximum intended load
- Scaffolds maintained in safe condition, not moved while in use
- Damaged or weakened scaffolds immediately repaired, not used until repairs are completed
- Safe access: ladder, ramp, etc.
- Overhead protection must be provided for overhead hazards
- Guardrails, midrails, and toeboards on all open sides/ends if more than 10 feet above ground or floor
- Wire mesh between toeboard and guardrail if people walk or work under scaffolds
- No work during storms, high winds, or ice and snow on scaffolds

###### 2. Specific requirements for different types: check 1910.28 (b)-(u)

##### B. Manually Propelled Mobile Ladder Stands and Scaffolds

###### 1. General requirements

- No sharp edges, burrs or other safety hazards
- Maximum work height not more than four times the minimum base dimension, unless outriggers, guys or braces added for stability
- Guardrails and toeboards for work levels 10 feet or more above ground or floor

2. Specific requirements - check 1910.29

# **Means of Egress - Subpart E**

## **Fire Protection - Subpart L**

### **I. Means of Egress**

#### **A. Overview**

##### **1. Egress from Life Safety Hazards**

- Fire
- Explosion
- Smoke (without fire)
- Toxic vapors
- Bomb Threat
- Storms (tornado, hurricane, etc.)
- Flash floods
- Nuclear radiation exposure
- Actions/threats by dangerous people
- Other reasons to exit the building

##### **2. Hazards can be compounded by:**

- Panic and confusion
- Poor visibility
- Lack of information or misinformation

##### **3. Definitions**

- Means of Egress: Continuous and unobstructed way of exit travel from any point in building to public way, consists of three parts: exit access, exit, and exit discharge
- Exit Access: Leads to an entrance to an exit
- Exit: Separated from all other spaces of the building to provide a protected way of travel to the exit discharge
- Exit discharge: Area between the termination of an exit and a public way
- High-hazard contents: Liable to burn with extreme rapidity or cause poisonous fumes or explosions
- Emergency Action Plan: Plan for workplace describing procedures to ensure employee safety from fire or other emergencies
- Emergency Escape Route: The route employees are directed to follow to evacuate the workplace or go to a designated refuge area

B. General Requirements

1. Fundamental requirements - All buildings intended for human occupancy shall have:

- Exits sufficient for prompt and convenient escape of occupants
- Exits and other safeguards designed to not depend on any single safeguard
- Building structures not causing danger to occupants during the time period necessary to escape
- No locks or devices to prevent emergency egress except in specialized facilities (mental, penal or corrective institutions with attendants on duty)
- Means of egress clearly visible and understandable
- Doorways which are not exits or exit access marked "Not an Exit"
- Adequate and reliable lighting for all exits
- Fire alarms when necessary
- Provisions for emergency egress shall not cause hazards under normal occupancy conditions

2. Additional requirements

- Occupants protected during building construction and repair to the same standards as when construction/ repair is complete
- Every means of egress must be continuously free of all obstructions to full instant use in case of fire or other emergency
- Every automatic sprinkler system, fire detection and alarm system, exit lighting system, fire door and other equipment must be continuously in proper operating condition

C. Components of Means of Egress

1. Permissible Exit Components

- All components must meet requirements
- Exit components either part of building or permanently attached

- If permissible component is attached or otherwise used improperly it is no longer permissible

2. Protective Enclosure of Exits

- 3 stories or less - 1 hour fire resistance
- 4 or more stories - 2 hour fire resistance
- Openings protected by approved self-closing fire doors
- Openings in exit enclosures limited to those necessary for access to enclosure and for egress from enclosure

3. Width and Capacity of Means of Egress

- Level (Class A ramps): 100 persons/unit (minimum width 44")
- Inclined (Class B ramps): 60 persons/unit (width 30 to 44")
- One unit is 22" wide
- Handrails may project no more than 5"
- Stair stringers may project no more than 1"
- Exit or exit access door cannot restrict width to less than minimum width

4. Egress Capacity and Occupant Load

- Capacity must be sufficient for occupant load
- Occupant load : maximum number of persons that may be in a space at any time
- Capacity of exits at a floor can be based on that floor's occupant loads
- Exit capacity must not decrease in the direction of exit travel

5. Arrangement of Exits

- When multiple exits are required for a floor, at least two of the exits must be as far from each other as possible

6. Access to Exits

- Exits must be readily accessible at all times



- Doors from a room to an exit or exit access must swing with exit travel when room is used by more than 50 people or used for high hazard occupancy
  - No exit access through bathroom or other room subject to locking
  - Access to exits shall be clearly recognizable
  - No mirrors on or near exit doors
  - Route of exit should never go toward high hazard location unless shielded
  - Minimum width of any exit: 22"
7. Exterior Routes of Exit Access: Outdoor exit access from one part of building to another or to exit. Specific requirements:
- Smooth, solid, level floors
  - Guard rails on open sides above ground level
  - Covered by roof if snow or ice could accumulate
  - Permanent, reasonably straight route of travel
  - No obstructions to use of route
  - No dead ends longer than 20 feet
8. Discharge from Exits - Requirements:
- Must discharge directly to street or open space leading to street
  - Discharge area must be large enough to accommodate everyone who uses that exit
  - Stairs and other exits must make clear the direction of egress
  - Stairs which continue past the exit must have partitions, doors or other effective means to direct people to the exit
9. Headroom Requirements
- Minimum ceiling height: 7' 6"
  - Projections from ceiling must be at least 6' 8" from the floor
10. Changes of Elevation - stairs or ramps required
11. Maintenance and Workmanship

- Continuously maintained free of all obstructions to full instant use
- Devices installed to restrict improper use of exit cannot prevent the emergency use of the exit
- All components of means of egress of substantial, reliable construction and built/installed properly

12. Furnishings and Decorations

- No furnishings or decorations which obscure or obstruct means of egress
- No furnishings or decorations which are explosive or highly flammable

13. Fire Protection Provisions

- All fire protection regularly inspected or tested and maintained

14. Exit markings - two kinds:

- Signs or markings which identify exit or exit access
- Signs or markings which identify doors or areas which are not means of egress

15. Exit markings - requirements:

- Every exit marked by clearly visible EXIT sign - letters at least 6" high, with a stroke at least 3/4" wide
- When way to an exit is not readily apparent, signs or markings similar to exit signs must be used
- Doors, passageways and stairways which are not means of egress must be clearly marked "Not an Exit"
- Exit signs must be illuminated by a reliable light source
- Exit signs and exit access signs must be readily visible and not obscured by furnishings, decorations or equipment

II. Employee Emergency Plans and Fire Prevention Plans (1910.38)

A. Emergency Action Plan

1. Plan Elements - Minimum Requirements
  - Escape Procedures and Escape Route Assignments
  - Critical Operations Shutdown Procedure
  - Procedure to Account for All Personnel
  - Rescue and Medical Duties Assignment
  - Means of Reporting Fires and Emergencies
  - Identification of Responsible Persons for Further Information
2. Plan must be in writing except for employers with 10 or fewer employees
3. Plan must address all potential emergencies - hazard audit required
4. Floor plans should be included in plan
5. Review plan with employees initially, whenever plan changes

B. Alarm System

1. Employers must have an employee alarm system complying with 1910.165
2. Alarms should be audible or visible
3. Alarms should have backup power
4. Alarm should be distinctive and recognizable

C. Evacuation

1. Employees must know evacuation plans
2. Refuge or safe areas should be in plan
3. Employees should move away from exits

D. Training

1. Sufficient number of employees must be trained to assist in evacuation
2. Employer must review plan with each employee at the following times:
  - Initially when the plan is developed

- Whenever the employee's actions or responsibilities change in the plan
  - Whenever the plan is changed
3. Employer must review plan with new employees during orientation - those parts of the plan the employee must know to protect themselves in an emergency.
4. Evacuation wardens should be trained:
- complete workplace layout
  - alternative escape routes
  - disabled employees who need extra assistance
  - hazardous areas to be avoided during emergencies
  - checking all rooms for trapped employees
  - verify all employees in safe area
5. Personal Protection - Required for anyone exposed to toxic substances
6. Medical Assistance
- Medical facility must be in close proximity to workplace or employer must train person(s) to give first aid
  - Eye washes must be provided if employees are exposed to corrosives, employees must be trained to use emergency washes
  - Employer must ensure ready availability of medical personnel for advice and consultation on employee health matters

E. Fire Prevention Plan

1. Plan Elements - Minimum Requirements:
- List of all major workplace hazards and proper handling & storage
  - List of potential ignition sources
  - List of fire equipment/systems
  - List of personnel responsible for maintenance of fire equipment
  - List of those responsible for control of fuel source hazards

2. Housekeeping
  - Employer must control flammable and combustible waste materials
  - Procedures must be in fire plan
3. Training
  - Employer must review fire prevention plan with employees on initial assignment
  - Written plan must be kept in workplace and available to employees
4. Maintenance
  - Heat-producing equipment must be maintained to prevent fire

### III. Fire Protection (1910.155-165)

#### A. Scope, Application and Definitions

1. Scope of Fire Protection Requirements
  - Fire Brigades
  - Portable Fire Suppression Equipment
  - Fixed Fire Suppression Equipment
  - Fire and Employee Alarm Systems
2. Application - All employment other than maritime, construction or agriculture
3. Definitions
  - Class A fire: Paper, wood, cloth, some rubber and plastics
  - Class B fire: Flammable or combustible liquids, flammable gases, greases, some rubber and plastics
  - Class C fire: energized electrical equipment, safety requires use of nonconductive extinguishing agent
  - Class D fire: Combustible metals such as magnesium, titanium, etc.
  - Dry chemical: Extinguishing agent, small particles of chemicals such as sodium bicarbonate

- Dry powder: Used to extinguish Class D fires
- Extinguisher rating: numerical rating given by Underwriters Laboratories, indicates extinguishing potential
- Fire brigade: Organized group of employees trained in basic fire-fighting operations
- Halon 1211, 1301: Extinguishing agents, electrically nonconductive chloroflourocarbon gases, effectively used for computer rooms and records areas to protect data
- Incipient stage fire: Fire in the initial (beginning) stage, can be controlled by portable fire extinguishers without the need for protective clothing or breathing apparatus
- Interior structural fire fighting: Fire suppression and/or rescue inside buildings or enclosed structures, fire is beyond incipient stage
- Multipurpose dry chemical: approved for use on Class A, B, and C fires

4. Standpipe System Definitions:

- Class I system: 2½” hose connection for fire departments
- Class II system: 1½” hose system for incipient stage fires
- Class III system: Outlets for both 2½” and 1½” hose systems
- Small hose: “ to 1½” hose for control of incipient stage fires

B. Fire Brigades

Not required, but if established must follow these requirements:

1. Organization:

Employer must have a written policy:

- Establishes fire brigade and its organizational structure
- Defines functions to be performed
- States training program requirements
- Employees must be physically capable to fight structural fires and perform emergency duties

2. Training and education

- Training before assignment to fire brigade and annually for all fire brigade members
- Quarterly training for fire brigade members who fight interior structural fires
- Training must be from qualified instructors

3. Fire Fighting Equipment

- Maintain and inspect at least annually
- Portable fire extinguishers and respirators used by fire brigades must be inspected monthly

4. Protective Clothing

- Required for employees who fight interior structural fires
- Foot and leg, body, hand, head, eye and face protection required

5. Respiratory Protection devices

- Must meet requirements of 1910.134 and 30 CFR 11 (MSHA standards)

C. Portable Fire Extinguishers

1. Scope and Application

- Placement, use, maintenance and testing of portable fire extinguishers provided for use by employees
- Does not apply to extinguishers provided for outdoor use
- When extinguishers are provided but not intended for employee use, employer has emergency action and fire prevention plans, only inspection, maintenance and testing requirements apply

2. Exemptions

- Standard does not require employees to use extinguishers. When extinguishers are not available, employer is exempt unless a specific (vertical) standard requires fire extinguishers

3. General Requirements:

- Mount, locate and identify extinguishers so they are readily accessible
- Only approved extinguishers shall be used
- Carbon tetrachloride or chlorobromomethane are prohibited
- Extinguishers must be fully charged and in operable condition, kept in designated places except during use
- Soldered or riveted shell inverting type extinguishers are prohibited

#### 4. Selection and Distribution

- Based on anticipated workplace fires
- Size and degree of hazard
- Class A: 75 foot maximum travel distance
- Class B: 50 foot maximum travel distance
- Class C: appropriate pattern for existing Class A or B hazards
- Class D: 75 foot maximum travel distance

#### 5. Inspection, Maintenance and Testing

- Visually inspected monthly
- Maintained annually
- Hydrostatically tested per Table L-1

#### 6. Training and Education

- Employees educated in use of extinguishers and associated hazards during orientation and annually
- Employees designated to use fire fighting equipment must be trained

### D. Standpipe and Hose Systems

1. Applies to small hose, Class II and Class III systems, NOT Class I systems
2. Protection of Standpipes
  - Protect against mechanical damage



- Damaged standpipes must be repaired promptly

### 3. Equipment

- Hose Reels and Cabinets: designed for prompt use in an emergency
- Hose Outlets and Connections: Must be located high enough to avoid obstruction, must be accessible
- Hose: Each required hose outlet shall be equipped with hose connected and ready for use
- Nozzles: Standpipe hose must be equipped with shut-off type nozzles
- Water supply: Minimum is 100 gallons per minute for 30 minutes

### 4. Tests

- Acceptance Tests: Pipes and hose for Class II and III systems must be hydrostatically tested before being put in service

### 5. Maintenance

- Water supply tanks must be filled except during repairs
- Valves in main pipe connections to water supply must be kept fully open except during repairs
- Hose systems must be inspected annually and after each use
- Any unserviceable portion of the system must be removed immediately and replaced with equivalent protection during repair
- Hemp or linen hoses must be unracked, inspected for deterioration and re-racked using a different fold pattern annually. Defective hoses must be replaced
- Trained persons must be designated to conduct all these inspections

## E. Fixed Fire Suppression Equipment

### 1. Automatic Sprinkler Systems

- Must provide complete coverage, only approved equipment allowed
- Systems must be properly maintained and tested
- New systems must have proper acceptance tests

- Every system must have automatic water supply providing design water flow for at least 30 minutes
- Vertical clearance between sprinkler heads and material below must be at least 18"

## 2. Fixed Systems - General Requirements

- Must be designed and approved for use on specific fire hazards they are expected to control
- If system becomes inoperable, employer shall notify employees and take necessary temporary precautions to assure their safety until the system is fixed
- Except where discharge is immediately recognizable, a distinctive alarm or signalling system must be provided
- Effective safeguards must be provided to warn employees against entry into discharge areas where the atmosphere remains hazardous
- Hazard warning or caution signs required for systems which use agents in hazardous concentrations
- Fixed systems must be inspected annually by qualified person
- Weight and pressure of refillable containers and weight of nonrefillable containers must be checked semi-annually

## 3. Total Flooding Systems with Potential Health and Safety Hazards to Employees

- Emergency Action Plan required for each area protected by total flooding system
- All systems must have a pre-discharge alarm
- Automatic actuation of the system must be by an approved fire detection device interconnected with the pre-discharge alarm system

## 4. Fixed Extinguisher Systems, Dry Chemical

- Dry chemical agents must be compatible with foams or wetting agents they are used with
- When dry chemical discharge may obscure vision, pre-discharge alarm is required
- Required rate: designed concentration must be reached within 30

seconds of initial discharge

5. Fixed Extinguishing Systems, Gaseous Agent

- Required rate: designed concentration must be reached within 30 seconds of initial discharge
- Halon systems: design concentration must be reached in 10 seconds
- Pre-discharge alarm may be required on Halon systems per 1910.162
- Maximum agent concentrations may be required on Halon systems per 1910.162

6. Fixed Extinguishing Systems, Water Spray and Foam

- Applies to systems installed to meet a particular OSHA standard
- Must be effective in at least controlling fire in protected area
- Drainage of water spray systems must be directed away from work areas and no emergency egress is permitted through drainage path

7. Fire Detection Systems

- Applies to all systems installed to meet a particular OSHA standard
- Only approved devices and equipment may be used
- All systems must be restored to normal operating condition after each test or alarm
- Fire detectors and detector systems must be tested and adjusted to maintain proper reliability
- Servicing, maintenance and testing must be performed by a trained person
- Fire detection equipment installed outdoors or in corrosive atmospheres must be protected from corrosion
- Detection equipment must be located and/or protected from mechanical or physical impact
- Fire detection systems installed for actuating fire extinguishing or suppression systems must be designed to operate in time to control or extinguish a fire
- Detection systems installed for the purpose of employee alarm and

evacuation must be designed and installed to provide a warning for emergency action and safe escape of employees

- Number, location and spacing of fire detectors must be based on recognized information

#### 8. Employee Alarm Systems

- Applies to all alarms installed to meet a particular OSHA standard
- Alarm must be perceived above ambient noise or light levels
- Alarm must be distinctive and recognizable
- Employer must explain to employees preferred means of reporting emergencies
- All devices, components, systems must be approved
- All employee alarm systems must be promptly restored to normal operating conditions after each test or alarm
- Non-supervised alarm systems must be tested every two months using a different alarm pull for each test
- Supervised alarm systems must be tested at least annually
- Testing must be done by trained personnel
- Manually-operated alarm pulls must be unobstructed, conspicuous, and readily accessible

# HAZARDOUS MATERIALS

## OSHA Subpart H

### I. Storage, Handling and Use of Flammable and Combustible Liquids (1910.106)

#### A. Hazards

##### 1. Definitions

- Aerosol: dispensed under pressure from container; mist, spray or foam
- Approved: by nationally recognized testing laboratory
- Boiling point: of liquid at 14.7 psia
- Container: Any can, barrel or drum
- Closed container: sealed so no liquid or vapor will escape at ordinary temperatures
- Fire area: separated by rest of building by 1-hour fire rating
- Flash point: minimum temperature a liquid gives off enough vapor to form an ignitable mixture with air near the surface of the liquid.
- Combustible liquid: Any liquid with a flash point at or above 100°F, includes Class II, IIIA and IIIB
- Flammable liquid: Any liquid with a flash point below 100°F, Class I
- PSIA: Pounds per square inch, absolute
- Portable tank: Closed container more than 60 US Gallons and not intended for fixed installation
- Safety can: Approved container, not more than 5 US Gallons, having spring-closing lid, spout cover and pressure relief
- Vapor pressure: Pressure in PSIA exerted by a volatile liquid, measures liquid's ability to evaporate

##### 2. Flammable (Explosive) Limits

- Flammable Limit = Explosive Limit

- Lower Flammable (Explosive) Limit abbreviated as LFL or LEL
- Upper Flammable (Explosive) Limit abbreviated as UFL or UEL
- All limits measured as percentage of vapor/gas concentration in air
- Flammable (Explosive Range): Vapor/gas concentration between LFL and UFL. When rapid combustion or explosion can occur
- Below LEL: Too “lean” to burn or explode (not enough vapor or gas)
- Above LEL: Too “rich” to burn or explode (not enough oxygen)

B. Container and Portable Tank Storage

1. This section does not apply to the following:

- Storage of containers in bulk plants, service stations, refineries, chemical plants and distilleries
- Class I or Class II liquids in fuel tanks of motor vehicle, boat, portable or stationary engine
- Flammable or combustible paints, oils, varnishes used for painting if not kept for over 30 days
- Beverages in containers up to 1 US gallon

2. Design, Construction and Capacity of Containers

- Only approved containers and portable tanks may be used to store flammable and combustible liquids
- Department of Transportation standard is 49 CFR 178
- Standards for plastic containers
- Portable tanks must have emergency venting
- Maximum allowable sizes of containers and portable tanks are specified based on the class of flammable or combustible liquid they contain

3. Design, Construction and Capacity of Storage Cabinets

- Class I and/or Class II limit: 60 US gallons
- Class III limit: 120 US gallons

- Standard permits metal or wooden cabinets
- Cabinets must limit inside temperature to 325°F in standardized 10-minute fire test
- All joints and seams must remain tight and doors remain securely closed during fire test
- Storage cabinets must be labelled “Flammable - Keep Fire Away”
- Bottom, top, door, and sides at least 18 gauge metal, double-walled with 1½” air space
- Door must have three-point lock, door sill must be at least 2" above bottom of cabinet

#### 4. Design and Construction of Inside Storage Rooms

- Construction must comply with NFPA 251-1969
- Storage Rating and Capacity
- Electrical wiring and equipment inside storage rooms used for Class I liquids must be approved under OSHA Subpart S (Electrical) for Class I, Division 2 Hazardous Locations
- Ventilation: gravity or mechanical exhaust system providing complete change of air at least 6 times per hour
- Storage: aisle at least 3 feet wide, no stacking of containers over 30 US gallons
- Dispensing by approved pump or self-closing faucet

#### 5. Storage Inside Building

- Flammable or combustible liquid storage must not limit use of means of egress
- Offices: storage prohibited except what is required for maintenance and operation of equipment. Closed metal containers in storage cabinet, safety cans, or inside storage room
- General Purpose Public Warehouses (see tables in 1910.106)
- Warehouses or Storage Buildings: (see tables in 1910.106)  
No materials within 3 feet of beams, girders, sprinkler heads or other fire protection equipment; aisles must be at least 3 feet wide

- Storage outside buildings: (see tables in 1910.106)

6. Fire control

- Suitable fire control devices at locations where flammable or combustible liquids are stored
- At least one fire extinguisher of a minimum rating of 12-B must be kept a maximum of 10 feet from any door to any room used for storage
- At least one fire extinguisher of a minimum rating of 12-B must be kept between 10 and 25 feet from any indoor Class I or II storage area which is not a storage room
- Open flames and smoking are not permitted in flammable or combustible liquid storage areas
- Materials which react with water must not be stored in the same room as flammable or combustible liquids

C. Industrial Plants

1. Scope

- Use of flammable or combustible liquids is incidental to principal business, or
- Flammable or combustible liquids are handled or used only in unit physical operations which do not involve chemical reactions

2. Incidental Storage or Use of Flammable or Combustible Liquids

- Flammable/combustible liquids must be stored in tanks/closed containers
- Maximum storage of Class IA liquids in containers: 25 US Gallons
- Maximum storage of Class IB, IC, II or III liquids in containers: 120 US Gallons
- Maximum storage of Class IB, IC, II or III liquids in a single portable tank: 660 US Gallons
- Flammable liquids must be kept in covered containers when not actually in use
- Leakage and spill disposal must be provided



- Flammable or combustible liquids can be transferred only by closed piping systems, safety cans, a device drawing through the top or by gravity through an approved self-closing valve
- Transfer operations must have adequate ventilation
- Sources of ignition are not permitted in areas where flammable vapors may travel
- Transferring liquids by pressurizing the container or portable tank is prohibited

### 3. Unit Physical Operations

- Each building or unit of equipment is accessible from at least one side for fire fighting and fire control purposes
- Emergency drainage systems must be provided to direct flammable or combustible liquid to safe location
- Adequate ventilation must be provided in operating areas, hazardous vapors must be trapped and removed

### 4. Tank Vehicle and Tank Car Loading and Unloading

- Must be separated from above-ground tanks, warehouses, similar facilities
- Minimum separation for Class I liquids: 25 feet
- Minimum separation for Class II and III liquids: 15 feet

### 5. Fire control

- Hazards must be evaluated
- Appropriate fire protection must be provided

### 6. Sources of Ignition

- Adequate precautions to prevent ignition of flammable vapors
- Examples of sources of ignition: open flames; lightning; smoking; cutting and welding; hot surfaces; frictional heat; static, electrical and mechanical sparks; spontaneous ignition, including heat-producing chemical reactions; and radiant heat
- Control of ignition sources is the second line of defense, minimizing leaks and spills is the primary objective

- Class I liquids shall not be dispensed into containers unless the nozzle and the container are electrically interconnected
- All electrical wiring and equipment installed according to requirements of OSHA Subpart S (Electrical)
- Repairs to Equipment: Hot work, use of spark-producing tools, and chipping operations must be supervised

#### 7. Housekeeping

- Established procedures to control leakage and prevent accidental escape of flammable or combustible liquids
- Spills shall be cleaned up promptly
- Combustible waste materials kept to a minimum, stored in covered metal receptacles, and disposed of daily

### D. Bulk Plants

#### 1. Storage

- Class I liquids stored in closed containers, aboveground storage tanks outside buildings, or underground storage tanks
- Class II and III liquids stored in containers, tanks in the building, aboveground storage tanks outside the building, or underground storage tanks

#### 2. Buildings

- Rooms where flammable or combustible liquids are stored or handled by pumps shall have exit facilities arranged to prevent occupants from being trapped
- Rooms where Class I liquids are stored or handled shall be heated only by non-igniting means, such as steam or hot water
- Adequate ventilation shall be provided for all rooms, buildings or enclosures where Class I liquids are pumped or dispensed

#### 3. Loading and Unloading Facilities

- Must be separated from above-ground tanks, warehouses, similar facilities
- Minimum separation for Class I liquids: 25 feet

- Minimum separation for Class II and III liquids: 15 feet
- Equipment used for transfer of Class I liquids cannot be used for transfer of Class II or III liquids

4. Static Protection

- When Class I liquids are loaded into tank vehicles
- When Class II or III liquids are loaded into vehicles which may contain vapors from Class I liquids
- When Class I liquids are dispensed into containers

5. Electrical Equipment: (see table referenced in 1910.106)

6. Sources of ignition

- Class I liquids cannot be handled, drawn or dispensed where flammable vapors may reach a source of ignition
- No smoking except in designated locations
- “NO SMOKING” signs posted where hazard from flammable liquid vapors is normally present

7. Drainage and Waste Disposal

- Prevent flammable or combustible liquids from being spilled into public sewers, drainage systems or natural waterways
- Separator boxes or other approved means are required
- Crankcase drainings and flammable or combustible liquids stored in tanks or tight drums outside building until removed from the premises

8. Fire Control

- Suitable fire control devices (small hose or portable fire extinguishers) in locations where fires are likely

E. Service Stations

1. Storage of flammable and combustible liquids

- Approved closed containers: maximum capacity 60 US gallons

- Underground tanks, tanks in special enclosures or aboveground

2. Dispensing

- Class 1 liquids: container must have tight closure with screw top or spring cover, must have spout - no spilling

F. Processing Plants

1. Scope

- Chemical operations and other chemical processes
- Does not apply to chemical plants, refineries or distilleries

2. Processing Building

- Buildings must be safely constructed with appropriate drainage, ventilation and explosion relief
- Emergency drainage systems required, must have traps or separators if connected to sewer

3. Liquid Handling

- Transfer of large quantities of flammable or combustible liquids by pumps or water displacement only
- Use of compressed air is prohibited

4. Fire control

- Portable extinguishers, water supply, fixed extinguishing systems and alarm systems shall be provided
- Hazards must be evaluated and appropriate fire control facilities must be provided for special hazards

5. Sources of ignition

- Prevent ignition of flammable vapors

6. Waste and Other Residues

- Combustible waste materials kept to a minimum, stored in covered metal receptacles, and disposed of daily

G. Refineries, Chemical Plants, and Distilleries

1. Also regulated by 1910.119 (Process Safety Management of Highly Hazardous Chemicals)

## II. Spray Finishing Using Flammable or Combustible Materials (1910.107)

### A. Introduction

#### 1. Scope

- Based on NFPA 33-1969
- Flammable and combustible finishing materials applied as a spray, combustible powders
- Does not apply to outdoor spray applications to structures
- Does not apply to small portable spraying apparatus not used repeatedly in the same location

#### 2. Definitions

- Dry Spray Booth: not equipped with water washing system, equipped with distribution or baffle plates, overspray dry filters or filter rolls, or dry powder collection systems
- Spray Area: Any area where dangerous quantities of flammable vapors and mists, or combustible residues, dusts or deposits are present due to spraying
- Spray Room: Power-ventilated fully-enclosed room used exclusively for open spraying of flammable or combustible materials
- Spray Booth: Power-ventilated structure provided to enclose or accommodate a spraying operation to confine and limit the escape of spray, vapor and residue, and safely direct them to an exhaust system

### B. Basic Safeguards

#### 1. Spray Booths

- Construction: steel, concrete or masonry, designed to sweep air currents toward exhaust outlet
- Interiors: smooth and continuous to prevent pocketing of residues and facilitate cleaning and washing
- Floors: If combustible, covered with non-combustible material

- Distribution or baffle plates: Promote even flow of air through booth, catch overspray before it enters exhaust duct; non-combustible material and removable on both sides for cleaning
- Dry-Type Overspray Collectors: See handout for regulations
- Frontal Area: Each spray booth having a frontal area larger than 9 square feet must have a metal deflector or curtain not less than 2½” deep installed at the upper outer edge of the booth over the opening
- Conveyor Openings: must be as small as practical
- Separation of Operations: Separated at least 3 feet or by partition or wall
- Cleaning: All portions readily accessible, clear space of 3 feet on all sides from storage or combustible construction
- Illumination: Only fixed lighting units, transparent panels must isolate spraying area from lighting unit and made of noncombustible material or so protected that breakage is unlikely, panels arranged so accumulation of spray isn’t ignited by heat from the light source

## 2. Electrical and Other Sources of Ignition

- Minimum Separation: No open flame or spark producing equipment within 20 feet of spraying area, unless separated by a partition
- No hot surfaces in spray area if deposits of combustible residues can accumulate
- Wiring Conformance: to this section and OSHA Subpart S (Electrical)
- No electrical equipment in spraying areas unless approved for ignitable residue and explosive vapors, except wiring in rigid conduit or boxes containing no taps, splices or terminal connections
- Electrical wiring located in spraying area but not subjected to deposits of combustible residues shall be explosion-proof approved for Class I Group D and otherwise conform to Class I Division 1 (Hazardous Locations) in OSHA Subpart S
- Electrical wiring, motors and other equipment outside but within 20 feet of spraying areas and not separated by partitions shall not produce sparks and shall conform to Subpart S, Class I Division 2

- Lamps: Electric lamps outside but within 20 feet of spraying areas and not separated by partitions shall be totally enclosed and protected by suitable guards or by location
- Portable lamps: Prohibited during spraying; if used during repair or cleaning, shall be approved for hazardous Class I locations
- Grounding: All metal parts of spray booths, exhaust ducts, and piping systems conveying flammable or combustible liquids or aerated solids shall be electrically grounded

### 3. Ventilation

- All spray areas must have mechanical ventilation to remove flammable vapors, mists or powders and control combustible residues; mechanical ventilation must be in operation at all times while spraying is being conducted and afterwards to allow vapors to be exhausted
- Each booth shall have an independent exhaust duct system discharging to the exterior of the building
- Fan-rotating element or casing shall be non-ferrous or non-sparking
- Electric motors driving exhaust fans shall not be placed inside booths or ducts
- Exhaust ducts shall have access doors for cleaning
- Freshly sprayed articles shall be dried only in spaces provided with adequate ventilation to prevent the formation of explosive vapors

### 4. Storage and Handling of Flammable and Combustible Liquids Used in Spray Finishing

- Comply with 1910.106 where applicable
- Quantity stored should not exceed a supply for 1 day or 1 shift
- Open or glass containers shall not be used
- Withdrawal of flammable or combustible liquids from containers more than 60 gallons shall be by approved pumps
- Withdrawal and filling of containers shall be done in mixing room or spraying area where ventilation system is in operation
- Adequate precautions taken to protect against spillage and sources of ignition when filling containers

- Containers supplying spray nozzles shall be closed type or provided with metal covers kept closed
- Containers supplying spray nozzles by gravity flow shall not exceed 10 gallons capacity
- No pressurized air on original shipping containers
- Pressurized air containers must be approved, have pressure gauge and relief valve
- All containers or piping attached to hose or flexible connection shall have a shutoff valve at the connection and kept shut when not spraying
- When pump is used, automatic pressure regulation required to protect hose, accessories and pipe
- All pressure hose and coupling shall be inspected at regular intervals
- Piping systems shall be of steel or other comparable material, shall be properly bonded and grounded
- Containers used to transfer flammable or combustible liquids shall be bonded and grounded

#### 5. Fire Protection

- Sprinklers not required, but must meet 1910.159 if installed
- Sprinkler heads kept free from deposits by daily cleaning if necessary
- Adequate supply of suitable portable fire extinguishers installed near all spraying areas

#### 6. Operations and Maintenance

- No spraying outside predetermined spraying areas
- All spraying areas keep free of deposits of combustible residues, daily cleaning if necessary. All cleaning tools must be non-sparking
- Residue scrapings and debris shall be immediately removed from premises and properly disposed of
- Approved metal waste cans for rags or waste, emptied daily or at end of shift



- Employee clothing left on premises overnight must be kept in metal lockers
- Solvents used for cleaning must have flash points over 100°F
- Cleaning using solvents must be done inside spray booths and ventilating equipment in operation
- Spray booths shall not be used for different types of coating materials if combining the materials may cause spontaneous ignition, unless all deposits of the first material are removed from the booth and exhaust ducts before the second material is sprayed
- “NO SMOKING” signs must be posted at all spraying areas and paint storage rooms

# Materials Handling

## OSHA Subpart N

### I. General Handling and Storage of Materials (1910.176-178)

#### A. Materials Storage (1910.177)

##### 1. Mechanical Equipment and Storage Areas

- Sufficient safe clearance allowed for aisles, loading docks, doorways, or whenever turns or passage must be made
- Permanent aisles and passageways shall be appropriately marked

##### 2. Secure storage

- Storage of materials shall not create a hazard - no sliding or collapse
- Stored materials stacked in tiers shall be stacked, blocked, interlocked, and limited in height

##### 3. Housekeeping

- Storage areas kept free from accumulation of materials to prevent tripping, fire, explosion, pests
- Vegetation control when necessary

#### B. Servicing single and multi-piece rims

##### 1. Types of Wheels and Tires

- Rim wheel: component assembly of wheel (multi or single piece), tire and tube plus other components
- Single-piece wheel: component assembly used to hold tire, form part of air chamber (tubeless tires) and means of attachment to axle
- Multi-piece wheel: vehicle wheel consisting of two or more parts, one part is side or locking ring that holds tire and other components on the rim wheel by interlocking the components when the tire is inflated
- Standard does not apply to automobile or light truck "LT" tires

##### 2. Hazards

- Sudden release of pressurized air contained in single-piece rim wheel
- Sudden release of pressurized air plus violent separation of wheel components in multi-piece rim wheel
- Sudden release of pressurized air can pick up and hurl employee

### 3. Employee Safety Training

- Employer must train all employees who service rim wheels
- No employee can service rim wheels unless they have been trained
- Minimum training requirement includes OSHA standard and manufacturer's rim manuals or the OSHA charts

### 4. Employee Hands-On Training

Employer must assure that each worker demonstrates and maintains the ability to service rim wheels by performing the following tasks:

- Demounting tires, including deflation
- Inspecting and identifying rim wheel components
- Mounting tires, including inflating them with restraining device or other safeguard
- Handling rim wheels
- Inflating tires when single-piece rim wheels are mounted on a vehicle
- Standing outside trajectory during inflation of tires
- Inspecting rim wheels following inflation
- Installing and removing rim wheels

### 5. Tire Servicing Equipment

- Employee must furnish restraining device for inflating tires on multi-piece wheels
- Employer must furnish restraining device or barrier for inflating tires on single-piece wheels, unless the single-piece wheel is bolted onto a vehicle during inflation

- Restraining device can be cage, rack or assemblage of bars and other parts that will constrain all rim wheel components during explosive separation or sudden release of air
  - Barrier can be fence, wall or other structure or object placed between single-piece rim and employee to contain rim wheel components during sudden release of air
6. Restraining devices must be removed from service if they show any of these defects:
- Cracks at welds
  - Cracked or broken components
  - Bent or sprung components
  - Corrosion or other structural damage
7. Other Requirements:
- Restraining devices removed from service must be repaired and reinspected
  - Current charts or rim manuals must be available in service area, including mobile service units
  - Only tools recommended in rim manual may be used
  - Employer must supply air line equipment with clip-on chuck, in-line valve with pressure gauge or pre-settable regulator, and enough hose to allow employee to stand outside trajectory
  - Mismatching of wheels and tires must be avoided
  - Multi-piece wheel components can only be interchanged according to the charts or rim manuals
  - All wheel components must be visually inspected by employee prior to assembly.
  - Any bent, corroded, broken or cracked wheel or component must be tagged “unserviceable” and removed from the service area
  - Damaged or leaky valves must be replaced
  - All wheels and components must be free of dirt, rust, scale or rubber buildup prior to tire mounting and inflation
8. Safe Operating Procedures: Multi-Piece Rim Wheels

- Tire must be completely deflated by removing valve core before wheel is removed, if tire has been driven underinflated or there is obvious or suspected damage to tire or wheel components
- Tire must be completely deflated by removing valve core before demounting
- Rubber lubricant must be applied to bead and rim mating surfaces when assembling the wheel and inflating tire (unless manufacture recommends against use)
- If tire is underinflated but has more than 80% of recommended pressure, tire may be inflated while rim wheel is on vehicle, but remote control inflation equipment must be used and no employee remains in the trajectory during inflation
- Tire shall be inflated outside a restraining device only to pressure sufficient to force the tire bead onto the rim ledge and create an airtight seal with the tire and bead
- Employees must not rest or lean their body or equipment against tire restraining device when a rim wheel is inside
- After tire inflation, tire and wheel must be inspected inside the restraining device to make sure they are properly seated and locked
- If adjustment is necessary, tire must be deflated by removing the valve core
- No hammering, striking or forcing wheel components while tire is pressurized
- Cracked, broken, bent or otherwise damaged wheel components must not be reworked, welded, brazed or otherwise heated. Heat must not be applied to multi-piece wheels
- Whenever multi-piece rims are being handled, employees must stay out of the trajectory unless employer can show that servicing requires employee to be in trajectory

#### 9. Safe Operating Procedures: Single Piece Rim Wheels

- Tire must be completely deflated by removal of valve core before demounting
- Mounting and demounting of tire must be performed only from narrow ledge side of wheel
- Tire must be mounted only on a compatible wheel of mating bead diameter and width

- Nonflammable rubber lubricant must be applied to bead and wheel mating surfaces before assembling rim wheel, unless manufacturer recommends against it
- If tire-changing machine is used, tire may be inflated only to minimum pressure necessary to force the tire bead onto the rim ledge and create an airtight seal
- If bead expander is used, it must be removed before valve core is installed and as soon as the rim wheel becomes airtight
- Tire may be inflated only when contained within a restraining device, positioned behind a barrier, or bolted on the vehicle with lug nuts fully tightened
- Tire must not be inflated when any flat, solid surface is in trajectory and within 1 foot of sidewall
- Tire must not be inflated to more than inflation pressure stamped in sidewall unless higher pressure is recommended by manufacturer
- Employees must stay out of trajectory when a tire is being inflated
- Heat must not be applied to a single-piece wheel
- Cracked, broken, bent or otherwise damaged wheels must not be reworked, welded, brazed or otherwise heated

#### C. Powered Industrial Trucks (1910.178)

##### 1. General Requirements

- Fork lifts, tractors, platform lift trucks, motorized hand trucks
- Approved powered industrial trucks must have label or mark from testing laboratory
- Modifications and additions which affect capacity and safe operation only with manufacturer's prior written approval
- Approved industrial truck: listed or approved for fire safety purposes by nationally recognized testing laboratory using nationally recognized testing standards

##### 2. Designations

- D: diesel powered, minimum acceptable safeguards to exhaust, fuel and electrical systems

- DS: diesel powered, additional safeguards to exhaust, fuel and electrical systems
- DY: Diesel powered, all DS safeguards plus no electrical equipment (including ignition) and equipped with temperature limitation features
- E: electrically powered, minimum acceptable safeguards against inherent fire hazards
- ES: electrically powered, additional safeguards to electrical system to prevent emission of hazardous sparks and limit surface temperatures
- EE: Electrically powered, all ES safeguards plus electric motors and all other electrical equipment completely enclosed
- EX: electrically powered, all electrical fittings and equipment for flammable atmospheres
- G: gasoline powered, minimum acceptable safeguards against inherent fire hazards
- GS: gasoline powered, additional safeguards to exhaust, fuel and electrical systems
- LP: LPG powered, minimum acceptable safeguards against inherent fire hazards
- LPS: LPG powered, additional safeguards to exhaust, fuel and electrical systems
- Atmospheres or locations must be classified hazardous or non-hazardous prior to consideration of industrial trucks being used
- Refer to Table N-1 of 1910.178 (c)(2)

### 3. Safety Guards

- All high-lift rider trucks must have overhead guards
- If fork lift carries load which can fall back on operator, it must have a vertical load back rest extension

### 4. Changing and Charging Storage Batteries

- Battery changing installations must be in areas designed for that purpose
- Facilities for flushing and neutralizing spilled electrolyte, fire protection, protecting charging apparatus from damage from trucks, and adequate ventilation must be provided

- Conveyor, overhead hoist or equivalent material handling equipment must be provided for handling batteries
- Smoking prohibited in charging area
- Precautions to prevent open flames, sparks, or electric arcs

#### 5. Trucks and Railroad Cars

- Highway trucks must set brakes and chock rear wheels to prevent rolling
- Wheel stops or other positive protection to prevent railroad cars from moving
- Fixed jacks may be necessary to support semitrailers if not coupled to tractor

#### 6. Operator Training

- No employee can operate a powered industrial truck unless properly trained and authorized to do so
- Employer must devise methods to train operators in safe operation of powered industrial trucks

#### 7. Truck Operations

- No person under elevated portion of any truck, loaded or empty
- No unauthorized personnel riding on powered industrial trucks. When riding is authorized, a safe place to ride must be provided
- Whenever a powered industrial truck is unattended, load engaging means must be fully lowered, controls must be neutralized, power shut off and brakes set
- Powered industrial truck is unattended whenever the operator is 25 feet or more from the truck but it is still in view, or whenever the operator leaves the vehicle and it is not in view

#### 8. Traveling in Powered Industrial Trucks

- All traffic regulations must be observed, including speed limits
- Driver must slow down and honk horn at cross aisles and other locations where vision is obstructed
- Railroad tracks must be crossed diagonally whenever possible
- Parking closer than 8 feet to center of railroad tracks is prohibited



- Trucks must be driven with load upgrade on grades more than 10%
- Dockboards or bridgplages must be properly secured before used
- Dockboards or bridgplages must be driven over slowly and rated capacity never exceeded

#### 9. Loading

- Only stable or safely-arranged loads shall be handled.
- Use caution when handling off-center loads
- Don't exceed the truck's load capacity

#### 10. Operation of Powered Industrial Trucks

- Trucks which are defective, unsafe or in need of repair must be taken out of service until restored to safe operating condition
- Fuel tanks must not be filled while the engine is running.
- Spills must be wiped up or completely evaporated and fuel cap replaced before starting engine
- Open flame must not be used for checking electrolyte level in batteries or gasoline level in fuel tanks

#### 11. Maintenance of Industrial Trucks

- All repairs must be made by authorized personnel
- No repairs can be made in Class I, II or III locations
- Repairs to fuel and ignition systems involving fire hazards must be done in designated locations
- Industrial trucks must be examined at least daily before being placed in service, or after each shift if used around-the clock
- Truck must not be placed in service if examination shows truck is unsafe

## II. Overhead and Gantry Cranes (1910.179)

### A. General Requirements and Definitions

#### 1. General Requirements

- Rated loads must be plainly marked on each side of crane
- Each hoist must have its rated load marked on it or its load block

## 2. Definitions

- Found in 1910.179(a)(1-65)

## B. Cabs

### 1. Location

- All controls within convenient reach of operator when facing load hook
- Full view of load hook in all positions

### 2. Hazards to avoid

- No convenient access to cab
- Gap more than 12" between ladder, stairs or platform and cab or bridge footwalk
- Fixed latter not safe or meeting code

## C. Footwalks and ladders

### 1. Footwalk should be provided on cab operated cranes

### 2. Footwalk constructions

- Standard railings and toeboards
- Continuous and permanently secured

### 3. Ladder or stairway must be provided

- Must comply with 1910.27

## D. Stops, Bumpers, Rail Sweeps and Guards

### 1. Stops

- Limit travel of trolley - NOT energy-absorbing
- Required on overhead or gantry cranes where trolley is on top of bridge
- Runway stops must be installed at ends of runway

2. Bumpers

- Energy-absorbing device usually required on overhead or gantry crane bridges
- Trolleys also usually require bumpers

3. Rail sweeps

- Required for bridge end truck wheels
- Extend below top of rail and project in front of truck wheels
- Help prevent crane from derailling

4. Guards

- Should be installed on hoisting ropes to avoid fouling or chafing
- Must be provided to prevent contact between hoisting ropes and bridge (electrical) conductors if they could come into contact

E. Brakes

1. Holding brakes required on each hoisting unit

2. Trolley and bridge brakes

- Bridge brake must be provided on cab-operated cranes with cab on bridge
- All overhead or gantry cranes with a cab on the trolley must also be provided with a trolley brake

F. Electrical Equipment

1. All wiring and equipment on overhead or gantry cranes must comply with OSHA Subpart S (Electrical)

2. Limit switch must be provided to stop hoist at upper limit of travel

G. Hoisting Equipment

1. Sheaves

- Grooved pulleys which carry hoisting ropes on overhead cranes
- Must be smooth and free of defects
- Sheaves in bottom blocks must have guards

2. Ropes

- Hoisting rope must have at least 2 wraps on the hoist drum at lowest point of loading hook travel
- Must be replaced with same size, grade and construction as original rope supplied by crane manufacturer

3. Hooks

- Must meet manufacturers recommendations
- Must not be overloaded

H. Inspections

1. Frequent inspections

- Daily to monthly intervals
- All functional operating mechanisms; air and hydraulic systems; chains, rope slings, hooks, and other lifting equipment inspected daily
- Hooks, chains and running ropes inspected monthly with certification record

2. Periodic inspection

- Complete inspection of crane at 1 month to 12 month intervals
- Brake system, limit indicators, power plant, electrical apparatus

I. Handling the Load

1. Overloading - no loading beyond rated load capacity
2. Balanced loads - every load must be well secured and balanced
3. No loads over personnel
4. Upper limit switch - must be tested at beginning of each shift
5. Operators are not allowed to leave controls while load is suspended

III. Slings

A. Definitions - see 1910.184 (b)

B. Safe Operating Practices

1. Whenever any sling is used:

- Damaged or defective slings must not be used
- Slings must not be shortened with knots, bolts, etc
- Sling legs must not be kinked
- Slings must not be loaded in excess of their rated capacities
- Slings used in basket hitch must have loads balanced
- Slings must be securely attached to loads
- Slings must be padded or protected from sharp edges of loads
- Suspended loads must be kept clear of all obstructions
- All employees must be kept clear of loads about to be lifted and suspended loads
- Hands or fingers must not be placed between sling and load while sling is being tightened around load
- Shock loading is prohibited
- Sling must not be pulled from under a load while load is resting on sling

C. Inspections

1. Sling, all fastenings and attachments must be inspected daily before use for damage or defects
2. Damaged or defective slings must be immediately removed from service

D. Types of Slings/Specific Requirements

1. Alloy Steel Chain Slings

- Must have permanently affixed durable identification stating size, grade, rated capacity and reach
- Must not be used with loads in excess of rated capacities in Table N-184-1 of 1910.184

2. Wire Rope Slings

- Must not be used with loads in excess of rated capacities shown in Tables N-184-3 through N-184-14 of 1910.184

3. Metal Mesh Slings

- Must have permanently affixed durable marking which states the rated capacity for vertical basket hitch and choker hitch loadings
- Handles must have rated capacity at least equal to metal fabric
- Must not be used with loads in excess of rated capacities shown in Table N-184-15 of 1910.184

4. Natural and Synthetic Fiber Rope Slings

- Must not be used with loads in excess of rated capacities shown in Tables N-184-16 through N-184-19 of 1910.184
- Must have a diameter of curvature meeting minimums specified in Figures N-184-4 and N-184-5 of 1910.184
- Temperature range: -20° to 180°F
- Use of repaired or reconditioned fiber rope slings is prohibited

5. Synthetic Web Slings

- Slings illustrated in Figure N-184-6 must not be used with loads in excess of rated capacities specified in Tables N-184-20 through N-184-22 of 1910.184

IV. Other Material Handling Equipment

- A. Crawler locomotive and truck cranes - see 1910.180
- B. Derricks - see 1910.181
- C. Helicopters - see 1910.183

# **Hazard Communication Introduction to Health OSHA Subpart Z**

## **I. Hazard Communication Standard (1910.1200)**

### **A. Purposes**

1. Goal: Employers and employees know about chemical hazards and how to protect themselves
2. Establishes uniform requirements to make sure hazards of all chemicals used in U.S. workplaces are evaluated and this hazard information is transmitted to affected employers and exposed employees

### **B. Scope and Application**

1. Covers all hazardous chemicals
2. Incorporates downstream flow of information

### **C. Limitations and Exceptions**

1. Limitations on laboratories
2. Labelling exceptions for:
  - Pesticides
  - Food, drugs, cosmetics
  - Distilled spirits, wine, malt beverages
  - Consumer products
3. Entire section does not apply to:
  - Hazardous waste
  - Tobacco or tobacco products
  - Wood or wood products
  - Food, drugs, cosmetics in retail store packaged for sale to consumers

- Food, drugs, cosmetics in workplace intended for employees' personal use

D. Definitions - See 1910.1200 (c)

E. Hazard Evaluation

1. Chemical manufacturers and importers are required to evaluate all chemicals and report information to their employees and employers who distribute or use their products
2. Chemicals considered hazardous:
  - 29 CFR 1910, Subpart Z, Toxic and Hazardous Substances
  - *Threshold Limit Values for Chemical Substances and Physical Agents in the Work Environment*, American Conference of Governmental Industrial Hygienists
3. Chemicals which are suspected or confirmed carcinogens:
  - National Toxicology Program, *Annual Report on Carcinogens*
  - International Agency for Research on Cancer, *Monographs*
  - Regulated by OSHA as a carcinogen

F. Written Hazard Communication Program

1. Employers must develop, implement and maintain at the workplace a written, comprehensive hazard communication program.
2. Program must include provisions for:
  - Container Labelling
  - Collection and Availability of Material Safety Data Sheets (MSDS)
  - Employee Training Program
  - List of Hazardous Chemicals in Each Work Area
  - Means Used by Employer to Inform Employees of Hazards of Non-Routine Tasks
  - Hazards Associated with Chemicals in Unlabelled Pipes
3. Written program must be available to:
  - Employees



- Designated Employee Representatives
- OSHA
- NIOSH

G. Labels and Other Warnings

1. Chemical manufacturers, importers and distributors must make sure containers of hazardous chemicals are labeled, tagged, or marked with:
  - Identity of the chemical
  - Appropriate hazard warnings
  - Name and address of the manufacturer
2. Employer must label, tag or mark each chemical and show hazard warnings appropriate for employee protection
3. Exemptions for in-plant container labels:
  - Employer can post signs or placards with hazard information for stationary containers with similar contents and hazards
  - Employer can substitute various types of written materials for container labels on stationary process equipment if they contain the same information and are readily available to employees
  - Employers are not required to label portable containers into which hazardous chemicals are transferred from labeled containers and are intended for immediate use of employees who make the transfer
  - Employers are not required to label pipes or piping systems

H. Material Safety Data Sheets (MSDS)

1. Chemical manufacturers and importers must develop an MSDS for each hazardous chemical they produce or import
2. Chemical manufacturers and importers must automatically provide MSDS at time of initial shipment of hazardous chemical to downstream distributor or user
3. Distributors must also ensure that downstream employers are provided with an MSDS for each hazardous chemical
4. Each MSDS must:

- be in English
  - include information regarding the specific chemical identity of the hazardous chemical(s) involved and their common names
  - include information on physical and chemical characteristics of each hazardous chemical
  - include known acute and chronic effects and related health information
  - include exposure limits
  - indicate whether the chemical is considered to be a carcinogen
  - Indicate precautionary measures
  - Give emergency and first-aid procedures
  - Identify the organization responsible for preparing the MSDS
5. Copies of each MSDS for all hazardous chemicals in the worksite must be readily accessible to employees in that area

#### I. List of Hazardous Chemicals

1. Employers must prepare a list of all hazardous chemicals in the workplace
2. Completed list should be checked against employer's MSDS's.
3. If there are hazardous chemicals with no MSDS's, the employer must obtain MSDS's from supplier, manufacturer, or importer

#### J. Employee Information and Training

1. Employers must establish a training and information program for employees exposed to hazardous chemicals:
  - at time of initial assignment
  - whenever a new hazard is introduced into their work area
2. Information - must include the following:
  - Existence of the hazard communication standard and requirements of the standard
  - Components of the hazard communication program in the employees' workplaces

- Operations in work areas where hazardous chemicals are present
  - Location of the written hazard evaluation procedures, communications program, lists of hazardous chemicals and required MSDS forms
3. Training - must include the following:
- How the hazard communication program is implemented in the workplace
  - How to read and interpret information on labels and MSDS
  - How employees can obtain and use available hazard information
  - Hazards of the chemicals in the work area (discussed by individual chemical or categories such as flammable)
  - Measures employees can take to protect themselves from the hazards
  - Specific procedures to provide protection such as engineering controls, work practices, and use of personal protective equipment
  - Methods and observations - such as visual appearance or smell - workers can use to detect presence of hazardous chemical

K. Trade Secrets

1. Standard strikes a balance between chemical industry trade secrets and need to protect exposed employees
2. Limited disclosure under specified conditions of need and confidentiality

II. Overview of Air Contaminants

A. Definitions

1. Dusts: Solid particles generated by handling, crushing, grinding, rapid impact, detonation and decrepitation of organic or inorganic materials such as rock, ore, metal, coal, wood and grain
2. Fumes: Formed when a material from a volatilized solid condenses in cool air, includes welding fumes, paint fumes
3. Mists: suspended liquid droplets generated by condensation of liquids from the vapor back to the liquid state, or by breaking up a liquid into a dispersed state such as by splashing and atomizing; includes acid mists, spray mists from spray finishing operations

4.     Fibers: Solid particles having a slender, elongated structure with length several times as great as their diameter, such as asbestos, talc, and fiberglass
5.     Gases: Formless fluids that expand to occupy the space or enclosure in which they are confined; a state of matter in which the molecules are unrestricted by cohesive forces; such as arc-welding gases, internal combustion engine exhaust gases.
6.     Vapors: Volatile form of substances that are normally in the solid or liquid state at room temperature and pressure.

B.     Related Hazards

1.     Chemical Hazards: excessive airborne concentrations of mists, vapors, gases, dusts or fumes.
2.     Biological hazards: insects, molds, fungi and bacterial contaminants
3.     Hazards can enter the body in the following ways:
  - Inhalation - directly into the lungs
  - Absorption - through skin
  - Ingestion - eating, drinking, smoking

C.     OSHA Standards, Subpart Z

1.     Agent Limitation - Expanded Health Standards
  - Specific standards (1910.1001-1101) for asbestos, vinyl chloride, arsenic, lead, benzene, formaldehyde, etc.
2.     Work Practices - Expanded health standards contain work practice requirements such as:
  - Exposure monitoring
  - Protective Equipment
  - Housekeeping
  - Hygiene Facilities
  - Medical Surveillance
  - Employee Training
3.     Permissible Exposure Limits (PELS)

- Air Contaminants are 1910.1000, Table Z-1-A
- Time Weighted Average (TWA): average concentration of chemical in workplace air over an 8-hour exposure period
- Short-Term Exposure Limit (STEL): Maximum exposure for any 15-minute period
- Ceiling Limit (C): Maximum exposure limit for instantaneous period

D. Carcinogens

1. Specific carcinogens regulated by OSHA:

- 4-Nitrobiphenyl
- alpha-Naphthylamine
- methyl chloromethyl ether
- 3,3'-Dichlorobenzidine
- bis-chloromethyl ether
- beta-Naphthylamine
- Benzidine
- 4-Aminodiphenyl
- Ethyleneimine
- beta-Propiolactone
- 2-Acetylaminofluorine
- 4-Dimethyl-aminoazobenzene
- N-Nitrosodimethylamine
- Cadmium
- Formaldehyde
- 4,4'-Methylenedianiline (MDA)

2. Specific sections in Subpart Z for each of these carcinogens

3. Specific hazard controls apply, such as:

- “Cancer-Suspect Agent” signs required for containers, work sites
- Medical Surveillance required
- Specific Training required
- Other specific controls in each section

#### E. Hazard Control

##### 1. Hierarchy of Control

- Engineering Controls - Reduce or eliminate hazard from workplace; such as pressurized cabs or control booths on equipment, use of remotely operated material handling equipment
- Work practices - Avoid exposure to hazard; such as removing all non-essential employees from potential exposure, wetting down dusty operations, locating employees upwind of possible hazards
- Personal Protective Equipment - Used last, after engineering controls and work practices have been tried

##### 2. Other Hazard Controls

- Exposure monitoring
- Protective Equipment
- Housekeeping
- Hygiene Facilities
- Medical Surveillance
- Employee Training

### III. Overview of OSHA’s sampling and instrumentation procedures

#### A. Air Samples

1. Short term (grab)
2. Integrated (full shift)

#### B. Grab sampling instruments

1. Detector tubes

2. Carbon monoxide indicators

3. Combustible gas indicators

4. Mercury vapor indicators

C. Full-shift sampling instruments

1. Dusts and fumes: air pump with filter

2. Gases and organic vapors: air pump using charcoal tube

D. Monitoring procedures

1. Appropriate sample

2. Accuracy

3. Frequency of sampling

- Instantaneous

- Integrated - full shift (usually 8 hours)

- Interval - several samples over a period of time, such as 5 samples over an 8 hour period

# **PERSONAL PROTECTIVE EQUIPMENT OSHA Subpart I**

## **I. General Requirements (1910.132)**

### **A. Personal Protective Equipment (PPE)**

#### **1. To Protect:**

- Eyes
- Face
- Head
- Extremities

#### **2. Types of Protective Equipment:**

- Protective Clothing
- Protective Shields and Barriers

#### **3. Required for:**

- Hazards of processes or environment
- Chemical hazards
- Radiological hazards
- Mechanical irritants

Which are capable of causing injury or impairment of any part of the body through:

- Absorption
- Inhalation
- Physical Contact

### **B. Requirements of Use**

#### **1. Employee-Owned Equipment**



- *EMPLOYER* must “assure adequacy” by maintenance and sanitation
- 2. Employer-Owned Equipment
- 3. Design
  - All PPE Must be of “Safe Design”
  - Must be designed for the work to be performed

## II. Eye and Face Protection (1910.133)

1. General Requirements
  - Must be provided by employer if they can prevent injury
  - Must be provided for flying objects, glare, liquids, injurious radiation or any combination of these hazards
2. Minimum Requirements
  - Adequate protection against hazards for which designed
  - Reasonably comfortable
  - Fit snugly
  - Not unduly interfere with movements of wearer
  - Must be durable
  - Must be capable of being disinfected
  - Must be easily cleanable
  - Kept clean and in good condition
3. Requirements for Corrective Lenses
  - Safety glasses with corrective lenses, or
  - Goggles worn over regular glasses, or
  - Corrective lenses mounted in goggles
4. Other Requirements
  - Must have manufacturer’s mark

- Limitations or precautions must be told to user and strictly observed
- Design, construction, testing and use in accordance with ANSI Z87.1-1968

#### IV. Respiratory Protection (1910.134)

##### A. Permissible Practice

1. Control occupational diseases caused by
  - Harmful dusts
  - Fogs
  - Fumes
  - Mists
  - Gases
  - Smokes
  - Sprays
  - Vapors
2. Engineering control measures must be used first, then respirators if engineering controls are not feasible or are being instituted
3. Respirators must be provided by the employer when needed to protect the health of the employee
4. Employee must use the respiratory in accordance with instructions and training

##### B. Minimal Acceptable Program Requirements

1. Employer must have a written program governing selection and use of respirators
2. Respirators must be selected for hazards to which the worker is exposed
3. Employer must train users in proper use of respirators and their limitations
4. Respirators must be regularly cleaned and disinfected
  - Respirators used by more than one employee must be cleaned and disinfected after each use

5. Respirators must be stored in a convenient, clean and sanitary location
6. Respirators used routinely must be inspected during cleaning
  - Worn or deteriorated parts must be replaced
  - Respirators for emergency use must be inspected monthly and after each use
7. Employer must do surveillance of:
  - work area conditions
  - degree of employee exposure or stress
8. Employer must regularly inspect and evaluate respirator program to determine continued effectiveness
9. Employees must be physically able to perform work and use respirator before being assigned to work requiring respirator
  - Local physician determines what health and physical conditions are pertinent
  - Respirator user's medical status *should* be reviewed annually
10. Approved or accepted respirators must be used when they are available; approved by U.S. Bureau of Mines

C. Types of Respirators

1. Air purifying
  - Uses chemicals to remove specific gases and vapors and/or...
  - Uses mechanical filters to remove particulate matter
  - Cannot be used in oxygen-deficient areas (oxygen content less than 19.5% by volume)
  - Also includes powered air-purifying respirators
2. Air-supplied Respirators
  - Deliver breathing air through a supply hose
  - Air delivered must be from a clean air source and free of contaminants
  - Type A: hose mask with blower
  - Type B: Hose mask without blower (not in common use)

- Type C: Air-line Respirator
  - Continuous flow: regulated amount of air flow, usually used with air compressor
  - Demand flow: delivers air only during inhalation, used with compressed air cylinders
  - Pressure-demand flow: Provides positive pressure during inhalation and exhalation to prevent inward leakage (negative pressure)

### 3. Self-contained breathing apparatus (SCBA)

- Provides complete respiratory protection against toxic gases and oxygen deficiency. Portable, uses oxygen or air.
- Closed-circuit: exhalation is rebreathed by wearer after carbon dioxide is removed and suitable oxygen concentration restored
- Open-circuit: exhalation is vented to the atmosphere and is not rebreathed

### 5. Gas masks

- Air-purifying respirators for specific air contaminants
- May be used for *escape only* from atmospheres which are immediately dangerous to life and health (IDLH); may *never* be used to enter IDLH environments

## D. Maintenance and Use of Respirators

1. Maintenance program must be designed for specific plant, working conditions, and hazards involved.
2. Maintenance program must include the following basic services:
  - Inspection for defects (including leak check)
  - Cleaning and disinfecting
  - Repair
  - Storage
3. Inspection of Respirators
  - All respirators must be inspected before and after each use.
  - All respirators for emergency use must be inspected monthly

- All SCBA must be inspected monthly
- Inspection records must be kept
- Replacement and repairs must be done only by experienced persons with parts designed for the respirator

## V. Other Types of Protection

### A. Head Protection (1910.135)

1. Helmets must meet ANSI Z89.1-1969
2. Types of Helmets ("Hard Hats")
  - Type 1 - Full brim, at least 1" wide
  - Type 2 - brimless with peak extending forward from crown
3. Classes of Helmets
  - Class A - General service, limited voltage protection
  - Class B - Utility service, high-voltage helmets
  - Class C - Special service, no voltage protection

### B. Foot Protection (1910.136)

1. Safety-toe footwear must meet ANSI Z41.1-1967

### C. Electrical protective devices (1910.137)

1. Must meet ANSI requirements as follows:
  - Rubber Insulating Gloves: J6.6-1967
  - Rubber Matting: J6.7-1935 (R1962)
  - Rubber Insulating Blankets: J6.4-1970
  - Rubber Insulating Hoods: J6.2-1950 (R1962)
  - Rubber Insulating Line Hose: J6.1-1950 (R1962)
  - Rubber Insulating Sleeves: J6.5-1962

D. Hearing Protection (1910.95)

1. Engineering or administrative controls must be tried first, then:
  - Ear plugs
  - Ear muffs
2. Ear plugs *and* ear muffs should be worn in extremely noisy situations
3. Hearing conservation program required

E. PPE for Fire Brigades (1910.156)

1. Fire-resistive clothing
  - Boots
  - Protective trousers
  - Fire-resistive coat
  - Protective gloves: cut, puncture, and heat resistant
  - Protective helmet with ear flaps and chin strap
  - Protective face shield where flying or falling materials may cause eye and face injuries
2. Respiratory protection - specific requirements in 1910.156

## **PPE UPDATE**

I. NEW General PPE Requirements

A. Hazard Assessment and Equipment Selection

1. Employer must assess workplaces to determine if :
  - a. Hazards ARE present
  - b. Hazards are LIKELY to be present
2. Employer must select, and have each affected employee use, types of PPE which will protect employees from hazards identified in the hazard assessment.

- a. Employer must *communicate* selection decisions to each affected employee.
  - b. Employer must *select PPE* which properly fits each affected employee.
- 3. Employer must have a *written* certification that the hazard assessment has been performed, including:
  - a. identification of the document as a certification of hazard assessment
  - b. identification of the workplace assessed
  - c. identification of the person certifying the assessment has been done.
  - d. date(s) of the hazard assessment

B. Defective and Damaged Equipment

- 1. Defective or Damaged PPE “shall not be used”

C. Training Requirements

- 1. Employer shall provide training to every employee required to use PPE
- 2. Each employee shall be trained to know at least the following:
  - a. When PPE is necessary
  - b. What type(s) of PPE are necessary
  - c. How to properly don, doff, adjust and wear PPE
  - d. The limitations of the PPE
  - e. Proper care, maintenance, useful life and disposal of PPE
- 3. Each affected employee shall demonstrate an understanding of this training and the ability to use PPE properly before being allowed to perform work requiring the use of PPE
- 4. The employer must *retrain* any employee if:
  - a. Changes in the workplace make previous training obsolete
  - b. Changes in type of PPE to be used make previous training obsolete
  - c. The employee doesn’t understand the training and/or doesn’t know how to use PPE properly.

5. The employer must have a *written* certification that each affected employee has received and understood the required training. Certification must include:
  - a. Identification of document as a PPE training certification
  - b. Name of each employee trained
  - c. Date(s) of training

## II. NEW Specific PPE Requirements

### A. Eye and Face Protection

1. Must protect employees from flying particles, molten metal, liquid chemicals, acids or caustic liquids, chemical gases or vapors, or potentially injurious light radiation. (This is a more specific definition of hazards)
2. Side protection is required when there is a flying object hazard. Detachable side shields (clip-on or slide-on) are permissible.
3. Prescription lenses - PPE must incorporate the prescription in its design or shall be worn over prescription lenses *without* disturbing the proper position of the prescription lenses or the PPE.
4. Eye and face PPE must have manufacturer “distinctly marked” on them
5. Injurious light radiation - filter lenses with a shade number appropriate for the work being performed are required (see list in new standard)
6. All eye and face PPE purchased after July 5, 1994 must meet ANSI Z87.1-1989. (PPE purchased before 7-5-94 only needs to meet 1968 standard)

### B. Head Protection

1. Hard hats (“protective helmets”) required to be worn in areas where there is a potential for injury to the head from falling objects.
2. Employees who work near exposed electrical conductors which could contact their heads must wear hard hats designed to reduce electrical shock (Class B helmets)
3. All hard hats purchased after July 5, 1994 must meet ANSI Z89.1-1986 (hard hats purchased before 7-5-94 only have to meet 1969 standard)

### C. Foot Protection

1. Affected employees shall wear protective footwear where there is a danger of foot injuries due to:



- a. falling and rolling objects, or
  - b. objects piercing the sole, and
  - c. where employee's feet are exposed to electrical hazards.
- 2. Protective footwear purchased after July 5, 1994 must meet ANSI Z41-1991 (purchased before 7-5-94 only needs to meet 1967 standard)

D. Hand Protection

- 1. Employers must select and require employees to use hand protection when employees' hands are exposed to hazards such as:
  - a. skin absorption of harmful substances
  - b. severe cuts or lacerations
  - c. severe lacerations
  - d. severe abrasions
  - e. punctures
  - f. chemical burns
  - g. thermal burns
  - h. harmful temperature extremes
- 2. Employers shall base the selection of appropriate hand protection on evaluation of performance characteristics of the hand protection relative to:
  - a. the tasks to be performed
  - b. conditions present
  - c. duration of use
  - d. hazards and potential hazards identified

# Electrical

## Subpart S

### I. Overview of Electricity and Basic Electrical Terms

#### A. Electricity - Overview

##### 1. Kinds of Electricity:

- Static (stationary)
- Dynamic (moving)

##### 2. Dynamic Electricity is Flow of Electrons Through a Conductor

##### 3. Dynamic Electricity Flows Through a Circuit - No Electrical Flow if Circuit Path is Broken

#### B. Conductors and Insulators

##### 1. Conductor: Material that is capable of carrying electric current; such as water, gold, silver, copper, or aluminum

##### 2. Insulator: Materials that don't carry electric current very well; such as wood, rubber glass, mica, plastic

#### C. Faults - Unintended electrical circuits

##### 1. Ground Fault - Fault between conductor and enclosure

##### 2. Short Circuit - fault between two conductors

#### D. Grounding and Bonding

##### 1. Path for electricity to return to service entrance instead of going through a person's body

##### 2. Effective grounding means path to ground is:

- permanent and continuous
- has ample current-carrying capacity to conduct safely any currents liable to be imposed on it
- has impedance sufficiently low to limit the potential above ground and to facilitate operation of overcurrent devices in the circuit

3. Effective Bonding means electrical continuity of grounding circuit is assured by proper connections throughout
- E. Voltage, Current and Resistance
1. Voltage - Electromotive Force or pressure causing electrons to flow, measured in Volts
  2. Current - Movement of electrons past a given point, measured in Amperes
  3. Resistance - Opposition to movement of electrons, measured in ohms
- F. Ohm's Law in DC Circuits
1. Direct Current (DC) - flows only one way: batteries use DC
  2. Ohm's Law:

## OHM'S LAW FOR DC CIRCUITS

$$E = I * R \quad I = E / R \quad R = E / I$$

E = Voltage in volts

I = Current in amperes

R = Resistance in ohms

\* = multiplied by

/ = divided by

- G. Ohm's Law in AC Circuits
1. Alternating Current (AC) - current flows back and forth very rapidly, usually 60 times a second. Electricity we get from the power company is AC.
  2. Electromagnetic Effect of Alternating Current - AC generates magnetic effects which cause resistance to circuit called reactance
  3. Impedance - Combination of resistance and reactance, measured in ohms
  4. Ohm's Law for AC Circuits (next overhead)
  5. With Ohm's Law, you can calculate any of the three values if you know the other two.

# OHM'S LAW FOR AC CIRCUITS

$$E = I * Z \quad I = E / Z \quad Z = E / I$$

E = Voltage in volts

I = Current in amperes

Z = Impedance in ohms

\* = multiplied by

/ = divided by

## II. Common Electrical Hazards

### A. Dangers to Employees

#### 1. Shock

- Electric shock occurs when the human body becomes part of an electrical path (circuit)
- Direct effects: Injury or death can occur whenever electric current flows through the human body.
- At 15 mA (milliamperes or 1/1000's of an ampere) a victim is unable to "let go" of the electrical circuit
- Currents of less than 30 mA can cause death. At about 100 mA, current causes heart attack
- Indirect effects: Even if current doesn't cause electrocution (death by electric shock) the shock can cause falls or crushing by machinery

#### 2. Burns: caused when person touches improperly wired electrical wiring or equipment, usually occur on the hands

#### 3. Arcs and Sparks:

- Arcs occur from high-amperage currents arcing through air
- Arcs are initiated by contact between two energized points
- Arcs can be caused by persons working on energized components or by equipment failure
- Temperatures as high as 35,000°F have been recorded in arc blast

- Thermal radiation from arc blast can cause severe burns
- Pressure wave from arc: Can cause ear damage, concussion, or pick up and throw person causing physical injury
- Projectiles: Pressure wave can propel large objects over a considerable distance; thermal radiation can cause electrical components to melt and be thrown
- Explosions: Arcs and sparks can cause explosive atmospheres to ignite (sparks are normal arcing caused by switch contacts or electrical motors)
- Fires: High resistance is a primary source of ignition, caused when wires are improperly spliced or connected. 2 ohms of resistance can cause 200 watts of heat energy

## B. Sources of Electrical Hazard

### 1. Improper wiring and/or fixtures

- Proper polarity on AC circuits: “Hot” wire has black insulation, “Return” wire has white insulation, “ground” wire has green insulation
- Reversed polarity: “Hot” and “Return” are reversed; doesn’t cause shock but could cause equipment to malfunction
- “Return” and “ground” reversed; could be dangerous under certain conditions
- “Hot” and “ground” wires reversed; extremely dangerous, metal case of equipment is now energized and can shock anyone who picks it up

### 2. Damaged and/or deteriorated cords

- Could expose bare wire and cause electrical shock; could also cause fire
- Damaged/deteriorated cords should be replaced or removed

### 3. Improper handling of tools and/or cords; some improper practices to avoid:

- Don’t carry tool by cord
- Don’t yank cord to disconnect it
- Keep cords away from heat, oil and sharp edges
- Do not hold fingers on switch button while carrying a plugged-in tool
- Remove all damaged electrical tools from use and tag them “do not use”

### III. Electrical OSHA Standards - Subpart S

#### A. Design Safety Standards for Electrical Systems (1910.302-308)

##### 1. Examination, Installation and Use of equipment - 1910.303(b):

- Suitability for installation and use in conformity with this subpart, and listed or labelled for that purpose
- Mechanical strength and durability of equipment to be used
- Adequacy of protection for parts designed to enclose and protect other equipment
- Electrical insulation
- Heating effects under conditions of use
- Arcing effects
- Classification by type, size, voltage, current capacity and specific use
- Other factors contributing to practical safeguarding of employees using or likely to come into contact with equipment

##### 2. Guarding of live parts - 1910.303(g)(2)

- By location in a room, vault, or similar enclosure that is accessible only to qualified persons
- By suitable permanent, substantial partitions or screens so only qualified persons will have access to the space within reach of live parts
- By location on a suitable balcony, gallery or platform
- By elevation of 8 feet or more above the floor or other working surface

##### 3. Grounding - 1910.304

- Grounded (return or neutral) and Grounding Conductors: must be identifiable and distinguished from all other conductors
- Polarity of Connections: No grounded conductor may be attached to any terminal or lead so as to reverse designated polarity
- Most metal cable trays, raceways and enclosures must be grounded except as provided by 1910.304 (f)(5)(i)(B)(1-3)
- Service equipment enclosures must be grounded

- Frames of electric ranges, wall-mounted ovens, counter-mounted cooking units, clothes dryers and metal outlet or junction boxes which are part of the circuit for these appliances must be grounded
- Fixed equipment: exposed non-current-carrying metal parts of fixed equipment which may be energized must be grounded under circumstances specified in 1910.304 (f)(5)(iv)
- Equipment connected by cord and plug must be grounded if in a hazardous location (as classified by OSHA standards) or likely to be used in wet and conductive locations
- Most cord-and-plug equipped appliances must be grounded; see 1910.304(f)(5)(v)(C)(1-8) for list

4. Hazardous Locations - 1910.307

- Areas where potential for explosion and fire exist because of flammable gases, vapors or dust or easily ignitable fibers or flyings
- Electrical equipment, wiring methods and installations of equipment in hazardous locations must be intrinsically safe, approved for the hazardous location, or safe for the hazardous location
- Intrinsically safe: Equipment approved for specific hazard class of location
- Approved for hazardous location: Equipment approved for specific class of location and specific gas, vapor, dust or fiber that will be present
- Approved: by recognized testing laboratory
- Safe for the hazardous location: employer demonstrates that the equipment will provide protection from hazards in that location
- Generally, equipment must not cause arcs, sparks, or generate enough heat to cause fire or explosion in hazardous atmospheres

B. Safety-Related Work Practices (1910.331-335)

1. Employees who must be trained include:

- Blue collar supervisors
- Electrical and electronic engineers
- Electrical and electronic equipment engineers
- Electrical and electronic technicians

- Electricians
- Industrial machine operators
- Material handling equipment operators
- Mechanics and Repairers
- Painters
- Riggers and Roustabouts
- Stationary engineers
- Welders
- Other employees who may face risk of injury due to electrical hazards

## 2. Content and Type of Training

- All work practices required by 1910.331-335 which pertain to their job assignments
- Any other electrically-related safety practices not specifically addressed by 1910.331-335
- Persons permitted to work on or near exposed energized parts must be trained to recognize, determine the nominal voltage of, and know the clearance distances from exposed energized parts
- Type of training: Classroom or on-the-job are required; amount of training required shall be determined by the risk to the employee

## 3. Selection and Use of Work Practices:

- De-energized parts: Live (energized) parts must be de-energized unless the employer can demonstrate that de-energizing introduces additional or increased hazards or is infeasible due to equipment design or operational limitations
- Subpart S has Lockout/Tagout requirements separate from the general Lockout/Tagout section 1910.147, but is permissible to combine them into a single procedure
- Electrical lockout/tagout procedure must be in writing
- Conductors and electrical equipment that have been de-energized but have not be locked or tagged out must be treated as energized parts



- Energized parts: If exposed energized parts are not de-energized, other safety-related work practices must be used to protect employees exposed to live parts
- Only qualified persons may work on energized electrical equipment
- Qualified persons must be capable of working safely on energized circuits
- Qualified persons must be familiar with special precautionary techniques, personal protective equipment, insulating and shielding materials and insulated tools

4. Use of Plug-and-Cord Equipment (including extension cords)

- Portable equipment must be handled in a manner which will not cause damage
- Flexible electric cords connected to equipment must not be used to raise or lower equipment
- Flexible cords must not be fastened with staples or anything that could damage the outer jacket or insulation
- Portable equipment must be visually inspected before use on any shift
- Portable equipment which remains connected must be visually inspected whenever it is relocated
- Defective or damaged items must be removed from service until repaired
- Extension cords used with grounding-type equipment must have a grounding conductor
- Plugs and receptacles must not be connected or altered in any manner which would prevent continuity of the grounding conductor
- The grounding pole of a plug must not be altered to allow it to be plugged into a current-carrying conductor
- Adapters which interrupt the continuity of the equipment grounding connection are prohibited
- Portable electric equipment and extension cords used in highly conductive work locations (such as those inundated with water) must be approved for those locations
- Employees' hands must not be wet when plugging and unplugging extension cords or equipment

- Energized plug and receptacle connections may be handled only with insulating protective equipment if the condition of the connection could provide a conducting path to the employee's hand
- Locking-type connectors must be properly secured after connection
- After a circuit is de-energized by a circuit protective device, the circuit may not be manually re-energized until it is determined that the circuit can be safely energized.
- Repetitive manual re-closing of circuit breakers or replacing fuses is prohibited
- Overcurrent protection devices may not be modified, even on a temporary basis
- Only qualified persons may perform testing work on electrical circuits or equipment

#### 5. Safeguards for Personal Protection

- Employees working in areas with potential electrical hazards must be provided with appropriate electrical protective equipment
- Protective equipment must be maintained in a safe and reliable condition and be periodically inspected or tested
- If insulating material of protective equipment may be subject to damage during use, the material must be protected
- Employees must wear non-conductive head protection whenever there is danger of head injury from electric shock or burns due to contact with exposed energized parts
- Employees must wear protective equipment for eyes or face if there is danger to injury to the eyes from electric arcs or flying objects
- Employees must use insulated tools or handling equipment if they might make contact with exposed energized conductors
- Fuse-handling equipment must be used to remove or install fuses when the fuse terminals are energized
- Ropes or handlines used near exposed energized parts must be nonconductive
- Protective shields, barriers or insulating materials must be used to protect employees from shock, burns, or other injuries

- When normally enclosed live parts are exposed for maintenance or repair, the parts must be guarded to protect unqualified persons
- Safety signs, symbols or tags must be used where necessary to warn employees about electrical hazards which may endanger them
- Barricades must be used in conjunction with safety signs where it is necessary to prevent or limit employee access to work areas exposing employees to exposed energized conductors
- Attendants must be stationed to warn and protect employees if signs and barricades do not provide sufficient warning

# **OSHA Recordkeeping Requirements 29 CFR 1903 & 1904**

- I. Recordkeeping and Reporting in the OSHA Act
  - A. Public Law 91-156 Section 8(c)(2)
    - 1. Rule-making authority given to OSHA
    - 2. Requires employers to keep records and make reports on work related deaths, injuries and illnesses
  - B. Public Law 91-156 Section 8(g)(1)
    - 1. Department of Labor authorized to compile, analyze and publish all reports of work related deaths, injuries and illnesses
    - 2. Bureau of Labor Statistics compiles these annual statistics
      - 1992 was first year for fatal statistics
      - BLS mails survey forms to employers
- II. Recordkeeping and Reporting Requirements of 29 CFR 1903 and 1904; Related Forms and Procedures
  - A. OSHA Notice (Poster) - 1903.2(a)(1)
    - 1. Must be posted in conspicuous place where notices to employees are normally posted
    - 2. Employer must take steps to ensure that posters are not altered, defaced, or covered by other material
    - 3. Copies of poster are allowed, minimum size is 8½ X 14, minimum print size is 10 points, caption 36 points
    - 4. Fine of up to \$7000 for not having the OSHA poster where inspector can see it (violation of posting requirement)
  - B. Log and Summary of Occupational Injuries and Illnesses (1904.2)
    - 1. OSHA-200 Form or similar is required
    - 2. Occupational Injuries and Illnesses which must be recorded:

- Fatalities, regardless of the time between injury and death, or the length of illness
- Lost workday cases, other than fatalities, that result in lost workdays
- Non-fatal cases without lost workdays that result in:
  - Transfer to another job
  - Termination of employment
  - Require medical treatment (other than first aid)
  - involve loss of consciousness or restriction of work or motion

3. Definitions:

- Medical treatment: administered by a physician or registered professional personnel under standing orders of a physician. Does not include first aid treatment, even if provided by physician or registered professional
- First Aid: any one-time treatment and any follow-up visit for the purpose of observation of minor scratches, cuts, burns, etc.
- Lost workdays: number of days after, but not including the day of injury or illness where the employee could have worked but could not perform all or part of his normal assignment during all or part of the workday because of the occupational injury or illness; can be consecutive or not

C. Annual Summary (1904.5)

1. All records are kept by calendar year
2. Employer must post an annual summary of occupational injuries and illnesses for each establishment (location)
  - Summary must have a copy of the year's totals from the OSHA-200 form
  - Must contain the following:
    - calendar year covered
    - company name
    - establishment name
    - establishment address
    - certification signature

- job title of person signing
- date signed
- Must use OSHA-200 form to present annual summary
- 3. If no injuries or illnesses occurred that year, annual summary must still be posted, with zeros in the title columns
- 4. Required dates for annual summary
  - Summary must be complete by February 1
  - Summary must be posted with OSHA poster from February 1 to March 1
- 5. Penalty of up to \$1000 for failure to post annual summary of occupational injuries and illnesses

D. Supplementary Record of Occupational Injuries and Illnesses (1904.4)

1. Employer must have supplementary records for all recordable occupational injuries or illnesses
2. OSHA 101 form or Workers' Compensation Employer's First Report of Injury form can be used to meet this requirement

E. Reporting Fatalities and Catastrophes (1904.8)

1. Accidents must be reported directly to the office of the OSHA Area Director if:
  - the accident is fatal to one or more employees, or
  - the accident results in the hospitalization of three or more employees (catastrophe)
2. Fatals and catastrophic accidents must be reported orally or in writing within 8 (EIGHT) hours
  - Report may be by telephone
3. Area Director may require additional reports as necessary concerning the accident

F. Exemptions from Reporting and Recordkeeping Requirements (1904.15-16)

1. Employers with fewer than 10 employees don't have to comply with reporting and recordkeeping requirements except reporting of fatalities and catastrophes
2. Employers don't have to comply with reporting and recordkeeping for employees in certain Standard Industrial Classification (SIC) codes

- SIC codes 55-69, 71-74, 77-78, 81-89
- These codes are for retail trade, finance, insurance, real estate and some service industries
- Employers still have to report fatalities, catastrophes, and fill out OSHA Occupational Injury and Illness Surveys

F. Proper Completion of OSHA-200 Forms

1. Follow directions on back of OSHA-200 form
2. Bureau of Labor Statistics publications:
  - *A Brief Guide to Recordkeeping Requirements for Occupational Injuries and Illnesses*
  - *Recordkeeping Guidelines for Occupational Injuries and Illnesses*

G. Recordkeeping Penalties

1. Knowingly making false statements or certifications on OSHA-200 logs can result in fine or imprisonment
  - Fines up to \$70,000
  - Imprisonment up to 6 months
2. Failure to fill out OSHA-200 logs when required: up to \$7000 penalty per occurrence
3. Failure to post annual OSHA-200 summary: up to \$7000 per occurrence
4. Failure to give employees or OSHA access to injury and illness records: up to \$7000 per occurrence

# **Machine Guarding**

## **OSHA Subpart O**

### **I. Basic Machinery Hazards**

#### **A. Motions**

##### **1. Rotating**

- Can grip clothing or pull on skin
- Projections on rotating parts increase danger of being caught
- In-running nip points: Rotating parts pull employee in between and cause crushing injury.

##### **2. Reciprocating**

- Back-and-forth or up-and-down
- Worker may be struck by or caught between moving and stationary parts

##### **3. Transverse**

- Movement in a straight, continuous line; such as a continuous belt
- Worker may be struck or caught in a pinch or shear point by a moving part

#### **B. Actions**

##### **1. Cutting**

- Involves rotating, reciprocating or transverse motion
- Finger, head and arm injuries can occur
- Flying chips or scrap material can hit eyes or face
- Saws, drills, lathes, routers

##### **2. Punching**

- Power applied to a slide (ram) for blanking, drawing or stamping metal or other materials
- Hazard occurs at point of operation where stock is inserted, held, and withdrawn by hand



- Typical machinery: punch presses, iron workers
- 3. Shearing
  - Applying power to a slide or knife to trim or shear metal or other materials
  - Hazard occurs at point of operation where stock is inserted, held and withdrawn by hand
  - Typical machinery: mechanical, hydraulic, or pneumatic shears
- 4. Bending
  - When power is applied to a slide in order to draw or stamp metal or other materials
  - Hazard occurs at point of operation where stock is inserted, held, and withdrawn by hand
  - Typical equipment: power presses, press brakes, tubing benders

## II. Basic Principles and Devices for Safeguarding Machinery

### A. Guards

- 1. Fixed
  - Permanent Part of Machine
  - Not dependent on moving parts to prevent access to danger areas
- 2. Interlocked
  - When opened or removed, power automatically shuts off and machine cannot cycle or start until the guard is back in place
  - May use electrical, mechanical, hydraulic, or pneumatic power or any combination of these
  - Interlocks should not prevent “inching” by remote control if required
  - Replacing the guard should not automatically restart the machine - manual restart is required
- 3. Self-Adjusting
  - Opening of barrier is determined by movement of stock

- Opening should only be large enough to admit stock
- After stock is removed, guard returns to rest position

## B. Devices

### 1. Perform one of several functions:

- Stop machine if hand or other part of body is inadvertently placed in the danger area
- Restrain or withdraw the operator's hands from the danger area during operation
- Provide a barrier which is synchronized with the operating cycle of the machine to prevent entry to the danger area during the hazardous part of the cycle

### 2. Presence-Sensing:

- Photoelectric (optical) or radiofrequency (capacitance) sensors stop machine if beam is broken by any part of the body

### 3. Electromechanical

- Probe or contact bar which descends to predetermined distance when operator initiates machine cycle
- Any obstruction prevents it from descending, which stops the machine

### 4. Pullback

- Series of cables attached to operator's hands, wrists and/or arms
- Cables pull operator's hands out of the danger area during hazardous part of machine cycle

### 5. Restraint

- Series of fixed cables attached to operator's hands, wrists and/or arms
- Cables keep operator's hands out of the danger area during operation

### 6. Safety Trip controls

- Provide quick means of deactivating machine in an emergency situation
- Pressure-sensitive body bar deactivates machine when depressed

- If anyone trips, loses balance or is drawn into the machine, applying pressure to the safety trip bar stops machine operation
- Safety triprod deactivates machine when pressed by hand during emergency situation
- Safety tripwire cables deactivate machine when pulled by hand during emergency situation

7. Two-hand Control

- Requires constant pressure by both hands to operate the machine; for part-revolution presses
- Hands are at a safe distance from the danger area while machine completes closing cycle

8. Two-hand Trip

- Requires both hands to activate machine cycle; for full-revolution presses
- Hands do not have to stay on the buttons after the machine is activated, so buttons must be placed far enough from point of operation so operator cannot move hands into danger area during hazardous part of cycle

9. Gate

- Removable barrier which protects operator at point of operation before machine cycle can be started
- Often designed to operate with every machine cycle

C. Location/Distance

1. Requires individual hazard analysis of machines involved
2. Examples:
  - Enclosure walls or fences
  - Dangerous parts high enough to be out of worker's reach

D. Feeding and Ejection Methods

1. Automatic feed
  - Reduces operator exposure to danger area by automatically running stock through machine

- Guards and devices must still be used when necessary
- 2. Semi-automatic feed
  - Operator uses mechanism to feed pieces into machine
  - Danger area is completely enclosed
- 3. Automatic Ejection
  - Uses air pressure or mechanical apparatus to automatically remove completed part from press
  - May be interlocked with operating controls to prevent next cycle until part is ejected
  - Requires additional safeguards to fully protect operator
- 4. Semi-automatic Ejection
  - Ejection mechanism controlled by operator
  - Helps keep operator's hands out of the danger area
- 5. Robots
  - Machines that load and unload stock, assemble parts, transfer objects or perform other tasks
  - Appropriate guards must be used to keep persons away from robot's area of travel

E. Other Safeguarding Aids

1. Awareness Barrier
  - Doesn't provide protection, but reminds person about danger area
2. Shields
  - Provide protection from flying particles, splashing cutting oils, or coolants
3. Holding Tools
  - Place and remove stock; allow operator to reach into danger area
  - Should not be used instead of other machine safeguards
4. Push Stick or Block

- Used for feeding stock into saw blade

### III. General Provisions of OSHA Subpart O

#### A. General Requirements - 1910.212(a)

##### 1. Machine Guarding

- One or more methods of machine guarding must be provided to protect employees from hazards created by:
  - Point of operation
  - Ingoing nip points
  - Rotating parts
  - Flying chips and sparks
- Guards must be affixed to the machine where possible and secured elsewhere if not possible
- Guards must not be hazards themselves
- Point of operation of machines whose operation exposes employees to injury (danger area) must be guarded
- Revolving drums, barrels and containers must be guarded by an enclosure which is interlocked with the drive mechanism
- When outer edges of fan blades are less than 7 feet above floor or working level, blades must be guarded with a guard having openings no larger than 1/2"

##### 2. Anchoring Fixed Machines

- Machines designed for fixed locations must be securely anchored to prevent walking or moving

#### B. Woodworking Machine Requirements - 1910.213

##### 1. General Machine Construction

- Each machine must be constructed to be free from sensible (able to be felt) vibration when the largest size tool is mounted and run idle (no cutting load) at high speed

##### 2. Machine Controls and Equipment

- Mechanical or electrical power control must be provided on each machine so operators can cut off power without leaving their position at the point of operation
- When injury to operator might result if machine restarts after power failure, machine must be prevented from automatically restarting
- Power controls and operating controls should be located within easy reach of the operators, so they don't have to reach over the machine

### 3. General Guarding Requirement for Woodworking Machines

- All woodworking machinery must be effectively guarded to protect the operator and other employees from hazards inherent to operation

### 4. Specific Woodworking Machine Requirements

- Table Saws:
  - Must have a automatically adjusting hood over the saw blade
  - Must have spreader aligned with blade, maximum 1/2" behind largest blade mounted in saw
  - Must have non-kickback fingers or dogs when used for ripping
  - Feed rolls and blades of self-feed circular saws must be protected by hood or guard
- Swing or Sliding Cut-Off Saws
  - Must have hood which completely encloses upper half of saw
  - Limit stops must be provided to prevent saw from extending beyond front or back edge of table
  - Saw must have effective device to return saw automatically to back of table when released
  - Inverted saws must be provided with hood which covers part of saw which protrudes above top of table or material being cut
- Radial Saws
  - Upper hood must completely enclose upper portion of blade down to end of saw arbor
  - Sides of lower exposed portion of blade must be guarded to full diameter of blade by automatically adjusting device

- Must have non-kickback fingers or dogs when used for ripping
- Adjustable stop must be provided to prevent forward travel of blade beyond position needed to complete cut
- Cutting head must return gently to starting position when released
- Bandsaws and Band Resaws
  - All portions of saw blade must be enclosed or guarded, except for working portion of blade
  - Bandsaw wheels must be fully encased
- Jointers
  - Hand-fed jointers with horizontal cutting heads must have an automatic guard
- Miscellaneous Woodworking Machines
  - All other woodworking machines must have suitable guards and exhaust hoods

## C. Abrasive Wheel Machinery - 1910.215

### 1. Machine Guarding

- Required for all abrasive wheel machines; specific exceptions listed in statute
- Safety guards must cover spindle end, nut, and flange projections; specific exceptions listed in statute

### 2. Work Rests

- On offhand grinding machines, adjustable work rests of rigid construction must be used to support the work
- Work rests must be kept adjusted closely to the wheel with a maximum opening of “ to prevent the work from jamming between the wheel and the work rest

### 3. Angular Exposure

- Abrasive wheel safety guards for bench and floor stands and cylindrical grinders must not expose the grinder wheel periphery for more than 65° above the horizontal plane of the wheel spindle

### 4. Exposure Adjustment

- Protecting member of abrasive wheel safety guard must be adjustable for variations in wheel size
- Distance between outer edge of wheel and adjustable tongue must never exceed ½"

#### 5. Mounting

- Immediately before mounting, all wheels must be closely inspected and sounded by the user (ring test) to make sure they are not damaged
- Spindle speed of machine must be checked before mounting wheel to make sure it doesn't exceed the maximum operating speed marked on the wheel

### D. Mechanical Power Presses - 1910.217

#### 1. Basic Rules

- Guards or devices required unless point of operation is ¼" or less
- Guard required over treadle on foot-operated presses
- Pedal counterweights must have the weight enclosed
- Full-revolution presses must have a single-stroke mechanism, except when automatically fed and points of operation have a fixed barrier guard
- Employers must regularly inspect power presses and maintain records of inspections and maintenance
- All point-of-operation injuries must be reported to OSHA within 30 days

### E. Mechanical Power Transmission Apparatus - 1910.219

#### 1. Mechanical system transmitting energy from power source to part of machine performing work; components include: flywheels, pulleys, belts, connecting rods, shafts, couplings, cams, spindles, chains, cranks and gears

#### 2. Guards required for

- All pulleys, belts, sprockets and chains, flywheels, shafts and shaft projections, gears and coupling or other rotating or reciprocating parts within 7 feet of the floor or working platform
- Flywheels protruding through a working floor
- Couplings with protruding bolts, nuts or set screws must have safety sleeve



3. Belts, pulleys and shafting located in rooms used exclusively for power transmission don't have to be guarded if OSHA requirements stated in standard are met

# **Control of Hazardous Energy (Lockout-Tagout) 1910.147**

## **I. Scope and Application**

### **A. Applies to general industry employment**

1. Covers servicing and maintenance of machines and equipment where unexpected start-up or release of stored energy could cause injury to employees
2. If employees are performing service or maintenance tasks that do not expose them to the unexpected release of hazardous energy, the standard does not apply.
3. Standard does not apply when:
  - servicing or maintaining cord and plug connected electrical equipment; equipment must be unplugged and plug must be under exclusive control of employee doing work
  - during hot tap operations that involve transmission and distribution systems for gas, steam, water or petroleum products in pressurized pipelines when continuity of service is essential and shutdown is impractical; employees must be provided with alternative protection which is equally effective

### **B. Normal Production Operations**

1. Normal operations are covered by rules in other General Industry Standards, so lockout/tagout usually doesn't apply.
2. Servicing and/or Maintenance Operations

Servicing such as lubricating, cleaning or unjamming equipment during production is covered by lockout/tagout when:

- Employee must remove or bypass machine guards or other safety devices resulting in exposure to hazards at point of operation
- Employee is required to place any part of their body in contact with the point of operation of the operational machine or piece of equipment
- Employee is required to place any part of their body into a danger zone associated with a machine operating cycle
- Machine must be de-energized and locks or tags applied to the energy isolation devices

- Normal servicing tasks that do not occur during production operations require lockout/tagout if employees can be injured by unexpected energization of the equipment
- For servicing operations which must be performed with the power on, such as troubleshooting, effective alternative protection must be provided to the employees
- Minor servicing tasks during normal production operations; routine, repetitive and integral to use of production equipment; are not covered by lockout/tagout if alternative protective is provided

## II. Lockout/Tagout Program

### A. Energy Control Program

1. Employer must establish in writing
2. Must include:
  - documented energy control procedures
  - employee training program
  - periodic inspection of the procedures
3. Must ensure that equipment is isolated from energy sources and rendered inoperative before servicing or maintenance if unexpected start-up or release of stored energy could occur
4. Energy Control Procedures
  - Written procedures with information that authorized employees must know to control hazardous energy during service or maintenance
  - If information for various machines is the same, single procedure may be sufficient
  - Multiple energy sources, different connecting means, or particular shutdown sequences require separate energy control procedures for different equipment
5. An Energy Control Procedure must include:
  - Statement on how the procedure will be used
  - Procedural steps needed to shut down, isolate, block and secure machines or equipment

- Steps designating safe placement, removal and transfer of lockout/tagout devices and who has the responsibility for them
  - Specific requirements for testing machines or equipment to determine and vary the effectiveness of locks, tags and other energy control measures
6. Procedure must include the following de-energizing steps:
- Preparing for shutdown
  - Shutting down the machine(s) or equipment
  - Isolating the machine of equipment from the energy source(s)
  - Applying the lockout or tagout devices to the energy-isolating devices
  - Safely releasing all potentially hazardous stored or residual energy
  - Verifying the isolation of the machine(s) or equipment prior to the start of service or maintenance work
7. Energy Control Procedure must include the following re-energizing steps:
- Assuring that machines or equipment components are operationally intact
  - Notifying affected employees that lockout or tagout devices are removed from each energy-isolating device by the employee who applied the device

**B. Energy-Isolating Devices**

1. Mechanism that prevents transmission or release of energy and to which all locks or tags are attached
2. Guards against accidental start-up or unexpected re-energization of equipment during servicing or maintenance
3. If the energy-isolating device is lockable, employer must use locks unless they can prove tags would provide protection at least as effective as locks
4. When tags are used, employer must (in addition to regular training) cover the following limitations of tags:
  - Tags are warning devices affixed to energy-isolating devices and do not provide the physical restraint of a lock
  - When a tag is attached to an isolating means, it is not to be removed except by the person who applied it, and is never to be bypassed, ignored, or otherwise defeated

- Tags must be legible and understandable by all employees
  - Tags and their means of attachment must be made of materials that will withstand the environmental conditions encountered in the workplace
  - Tags may not evoke a false sense of security; they are only part of the overall energy control program
  - Tags must be securely attached to the energy-isolating devices so they cannot be detached accidentally during use
5. Employer must comply with all tagout-related provisions plus implement additional safety measures that can provide the level of safety equivalent to that obtained by using lockout:
- Removing and isolating a circuit element
  - Blocking a controlled switch
  - Opening an extra disconnecting device
  - removing a valve handle to reduce the potential for any accidental energization
6. Whenever major repair, replacement, renovation or modification of machines and equipment is performed and whenever new machines or equipment are installed, the employer must ensure that the energy-isolating devices are lockable

#### C. Requirements for Lockout-Tagout Devices

1. Devices must be singularly identified
  - employee name or ID number
2. Must be the only devices used for controlling hazardous energy
3. Must meet the following requirements:
  - Durable: must withstand environment they are exposed to for the duration of the exposure; tagout devices must not deteriorate or become illegible
  - Standardized: lockout and tagout devices must be standardized by color, shape or size; tagout devices must be standardized according to print and format
  - Substantial: Must be strong enough to minimize early or accidental removal
    - Locks must prevent removal except by excessive force of special tools such as bolt cutters

- Tags must be non-reusable, attachable by hand, self-locking and non--releasable with a minimum locking strength of at least 50 pounds
- Device for attaching tag must be one-piece nylon cable tie (or equivalent) which will withstand all environments and conditions
- Identifiable: Locks and tags must clearly identify the employee who applies them; tags must also warn against hazardous condition, must include wording such as: DO NOT START, DO NOT OPEN, DO NOT CLOSE, DO NOT ENERGIZE, DO NOT OPERATE

### III. Employee Training

#### A. Employer must provide:

1. Effective initial training
2. Retraining as necessary
3. Certification that such training has been given to all employees covered by the standard; must contain:
  - Each employee's name
  - Dates of training

#### B. Three types of employees for Lockout/Tagout training:

1. Authorized
  - Have responsibility for implementing energy control procedures
  - Perform service and maintenance on equipment which must be locked/tagged out
2. Affected: Equipment operators or users
3. Other: All other employees

#### C. Training Requirements

1. Amount and Type of Training based on:
  - Relationship of that employee's job to the machine or equipment being locked/tagged out

- Degree of knowledge relevant to hazardous energy they must possess

D. Types of Training for Specific Types of Employees

1. Authorized Employees Must Be Trained on:

- Details about the type and magnitude of the hazardous energy sources present in the workplace
- Methods and means necessary to isolate and control those energy sources

2. Affected and Other Employees Must Be Trained on:

- Recognizing when energy control procedures are being implemented
- Understanding the purpose of the procedure and the importance of not attempting to start up or use the equipment that has been locked or tagged out

E. Additional Training Requirements

1. Should deal with the equipment, types of energy and hazards specific to the workplace being covered

2. Retraining must be provided whenever there is:

- a change in machines, equipment or processes that present a new hazard, or
- a change in the energy control procedures

3. Additional Retraining Must Be Provided When

- Whenever a periodic inspection reveals, or
- Whenever the employer has reason to believe there are deviations or inadequacies in the employee's knowledge or use of the energy control procedure

III. Lockout/Tagout Procedures

A. Periodic Inspections

1. Inspections must be performed at least annually:

- Assure the energy control procedures continue to be implemented properly
- Assure that employees are familiar with their responsibilities under those procedures

2. Certification of Inspections, must include:
  - Must identify machine or equipment on which the energy control procedure is used
  - Date of inspection
  - Employees included in inspection
  - Name of person performing inspection
3. Lockout procedure inspections must also include:
  - Review between inspector and each authorized employee of that employees responsibilities under the energy control procedure being inspected
4. Tagout procedure inspections must also include:
  - Review on the limitation of tags for each affected and authorized employee

B. Application of Controls and Lockout/Tagout Devices

1. Lockout/tagout procedure must include specific elements and actions that must be implemented in sequence:
  - Prepare for shut down
  - Shut down machine or equipment
  - Apply lockout or tagout device
  - Render safe all stored or residual energy
  - Verify the isolation and de-energization of the machine or equipment
2. Removal of lockout/tagout devices and restoring energy to machine or equipment must include the following procedures:
  - Inspect work area to ensure non-essential items have been removed and machine/equipment components are intact and capable of operating properly
  - Check area around machine or equipment to ensure all employees are in a safe area
  - Notify affected employees immediately after removing locks or tags and before starting equipment or machines
  - Make sure that locks and tags are removed **ONLY** by those employees who attach them



3. Testing or Repositioning of Machines: Temporary removal of locks/tags must be done in this sequence:
  - Clear the machine/equipment of tools and materials
  - Remove employees from machines or equipment area
  - Remove lockout/tagout devices
  - Energize machine/equipment and proceed with testing or repositioning
  - De-energize all systems, isolate machine/equipment from energy source, reapply lockout/tagout
4. Outside personnel (contractors, etc)
  - Onsite employer and outside employer must inform each other of their respective lockout/tagout procedures
  - Each employer must ensure that their employees understand and comply with all restrictions and/or prohibitions of the other employer's energy control program
5. Group lockout or tagout
  - Each employee performing service or maintenance must be protected by their personal lockout/tagout device
6. Shift or personnel changes
  - Specific procedures must ensure the continuity of lockout/tagout protection during shift or personnel changes

# **Welding, Cutting and Brazing**

## **OSHA Subpart Q**

### **I. General Hazards and OSHA Standards Related to Storage, Handling and Use of Compressed Gases**

#### **A. Hazards**

##### **1. Stored Energy**

- Gases are compressed
- Accidental release could be very hazardous
- Breaking off the cylinder valve can cause the cylinder to “take off like a rocket”

##### **2. Flammability**

- Acetylene

##### **3. Chemical Toxicity**

- Phosgene, Mercury and Lead vapor

##### **4. Asphyxiating properties**

- Nitrogen, Carbon Monoxide

##### **5. Thermal Energy**

- Acetylene

#### **B. General Requirements - 1910.101**

##### **1. Inspections**

- Visual Inspections required
- Must be conducted per DOT regulations - 49 CFR 171-179 and 14 CFR 103

##### **2. In-plant handling and storage**

- Must be done per Compressed Gas Association Pamphlet P-1-1965

3. Safety relief devices

- Must be installed and maintained per Compressed Gas Association pamphlets S-1.1-1963 and 1965 addenda and S-1.2-1963

II. Critical Hazards and OSHA Standards Related to Oxyfuel, Arc, and Resistance Welding Equipment

A. General Requirements - 1910.252

1. Fire Prevention - Basic Precautions:

- If the object to be welded cannot be readily moved, all movable fire hazards in the vicinity must be taken to a safe place
- If the object to be welded or cut cannot be moved and if all the fire hazards cannot be removed, guards must be used to confine heat, sparks and slag and protect fire hazards
- If these requirements cannot be met, welding or cutting cannot be done

2. Special Precautions

- Fire extinguishing equipment must be ready for instant use
- Fire extinguishing equipment includes pails of water, buckets of sand, hose or portable extinguishers
- Fire watchers are required whenever welding or cutting is performed in locations where other than a minor fire might develop, or whenever:
  - Combustible materials (building or contents) closer than 35 feet
  - Combustibles more than 35 feet but easily ignitable by sparks
- Fire watch must be maintained for at least ½ hour after completion of welding or cutting operations

3. Welding or cutting is prohibited:

- In areas not authorized by management
- In sprinklered buildings where such protection is impaired
- In the presence of explosive atmospheres

4. Protection of Personnel

- Fall protection is required:

- Railings
- Safety belts
- Life Lines
- Equally effective safeguards
- Eye protection is required:
  - Helmets or Hand Shields for arc welding or cutting
  - Helmets/shields must insulate from heat and electricity
- Protective clothing is required:
  - In accordance with 1910.132
  - Protective eyewear
  - Safety shoes
  - Fire-resistant clothing
  - Fire-resistant gloves
  - No pockets on shirt, no cuffs on trousers
- Confined Spaces
  - Adequate ventilation required
  - Gas cylinders and welding machines must be left outside
  - Electrodes removed or gas valves turned off when not in use

## B. Oxygen-Fuel Gas Welding - 1910.253

### 1. Acetylene

- Maximum pressure for acetylene:
  - 15 psig (pounds per square inch, gauge), or
  - 30 psia (pounds per square inch, absolute - gauge pressure plus atmospheric pressure)
- Acetylene at higher pressures must be stored in cylinders in solution with a solvent such as acetone

- Acetylene can explode at pressures higher than 15 psig or 30 psia

## 2. Cylinders - Storage

- Keep cylinders away from radiators and other heat sources
- Keep cylinders at least 20 feet from combustible materials
- Keep cylinders in an assigned place away from any areas where they might be knocked over, damaged by passing or falling objects, or tampered with
- Empty cylinders must have valves closed
- Valve protection caps must be in place when cylinders are not in use
- Maximum indoor storage for LPG cylinders is 2000 cu. ft. or 300 lbs
- Acetylene cylinders must be stored valve end up
- Oxygen cylinders in storage must be separated from combustibles and fuel-gas cylinders at least 20 feet or by a non-combustible barrier at least 5 feet high with a fire resistance rating of at least ½ hour

## 3. Cylinders - Operation

- Cylinders and apparatus must be kept free from oily or greasy substances
- Oxygen cylinders and apparatus must not be handled with oily or greasy hands or gloves
- A jet of oxygen must never be permitted to strike an oily surface, greasy clothes, or enter a fuel oil or storage tank
- Valve protection caps must not be used for lifting cylinders
- If the cylinder valve outlet becomes clogged with ice, thaw with warm - *not boiling* - water
- Unless cylinders are secured on a special truck, regulators must be removed and valve protection caps must be put in place before cylinders are moved
- Cylinders not having fixed hand wheels must have keys, handles or non-adjustable wrenches on valve stems when these cylinders are in use
- Unless connected to a manifold, a regulator must be attached to the cylinder before use
- Regulators must be proper for the type of gas and service pressure

- Regulator must be clean and have a clean filter installed in its inlet nipple
- Before attaching the regulator:
  - Remove protective cap from cylinder
  - Stand to one side of the cylinder
  - Open the cylinder valve slightly for an instant and close it, to remove dust or dirt from valve
- Before a regulator is removed from a cylinder valve, the valve must be closed and the gas released from the regulator
- Acetylene cylinder valve must not be opened more than 1½ turns of the spindle

#### 4. Manifolding of Cylinders

- Portable Outlet Headers must not be used indoors except for temporary service where conditions preclude a direct supply from outlets located on the service piping system
- Each outlet on the service piping must be equipped with a readily accessible shut-off valve
- Each service outlet on portable outlet headers must be provided with a valve assembly that includes a detachable outlet seal cap, chained or otherwise attached to the body of the valve

#### 5. Service Piping Systems

- Pipe must be at least Schedule 40 and fittings must be at least standard weight in sizes up to and including 6" nominal
- Schedule 40 pipe is standard black iron pipe which has a working pressure up to 125 psi and is always tested before use
- When oxygen is supplied to a service piping system from a low pressure oxygen manifold without an intervening pressure regulating device, the piping system must have a minimum design pressure of 250 psig
- A pressure regulating device must be used at each station outlet when the connected equipment is for use at pressures less than 250 psig
- Piping for acetylene or acetylinic compounds must be steel or wrought iron
- Unalloyed copper must not be used for acetylene or acetylinic compounds except in listed equipment

6. Installation of Service Piping Systems

- All piping must be:
  - run as directly as possible
  - protected against physical damage
  - designed for expansion and contraction
  - designed to withstand jarring and vibration
- After assembly, piping must be thoroughly blown out with air, nitrogen, or carbon dioxide
- Oxygen piping must be blown out with *oil-free* air, nitrogen or carbon dioxide
- Low points in piping carrying moist gas must be drained
- Underground and outdoor piping and tubing must be covered or painted to protect against corrosion

7. Testing

- Piping systems must be tested and proved gas tight at 1½ times maximum operating pressure
- Piping systems must be thoroughly purged of air before being placed in service
- Material used for testing oxygen must be oil-free and non-combustible
- Flames must not be used to detect leaks

8. Service piping systems must be protected by pressure relief devices:

- Set to function at not more than the design pressure of the systems
- Discharging excessive pressure upwards to a safe location

9. Piping Protective Equipment

- Approved protective equipment must be installed in fuel-gas piping to prevent:
  - Backflow of oxygen into the fuel-gas supply system
  - Passage of a flashback into the fuel-gas supply system

- Excessive back pressure of oxygen into the fuel-gas supply system
- Three protective functions may be combined in one device or provided by separate devices

#### 10. Hose and Hose Connections

- Welders must use proper hoses
  - Fuel gas hose is usually red (sometimes black) and has left-handed threaded nut
  - Oxygen hose is green and has a right-handed threaded nut
- Hose and connections must be clamped or otherwise securely fastened to withstand, without leakage, twice the normal service pressure or not less than 300 psi
  - Oil-free air or oil-free inert gas must be used for this test
- Hose showing leaks, burns, worn places or other defects must be repaired or replaced

#### 11. Pressure-Reducing Regulators

- Regulators must be used only for the gas and pressures for which they are intended
- Repairs must be performed by skilled and properly instructed mechanics; contact manufacturer
- Gages on oxygen regulators must be marked “USE NO OIL”

### C. Arc Welding

#### 1. Introduction - General Information

- Arc welding uses an electric current passing through the welding rod (or electrode) to jump or arc across a gap; arc produces intense heat necessary to weld or cut metal
- Shielding of the arc uses a gas or flux to keep air away from the molten metal of the weld; makes the weld stronger

#### 2. Shielded Metal-Arc Welding (SMAW)]

- Commonly referred to “stick” welding
- Electrode is covered by flux, which vaporizes and keeps air out of the weld



3. Gas Metal Arc Welding (GMAW)

- Commonly known as “MIG” Welding
- Gas shields the arc from air
- Electrode is fed to the weld, where it melts and is deposited as weld metal

4. Gas Tungsten Arc Welding (GTAW)

- Commonly known as “TIG” Welding
- Tungsten electrode does not melt
- Welding rod melts and is deposited as weld metal
- Shielding is provided by inert gas

5. Flux Core Arc Welding (FCAW)

- Electrode melts and is deposited as weld metal
- Shielding is provided by flux in the tubular electrode
- Additional shielding may be obtained from gas

6. Submerged Arc Welding (SAW)

- Arc is shielded by a blanket of granular, fusible flux
- Blanket eliminates sparks, spatter and smoke; decreases fumes

7. Arc Cutting

- Cutting metal by melting it with an arc between electrode and metal

8. Plasma Arc Cutting (PAC)

- Metal is cut by melting a localized area with a constricted arc and removing the molten material with a high velocity jet of hot, ionized gas

9. Air Carbon-Arc Cutting

- Metal is cut by melting with the heat of an arc, using an air stream to facilitate cutting

10. Arc Gouging

- Using arc to make a groove or bevel in the metal surface

11. Voltage Limits for Welding

- For AC welding under wet conditions or warm areas where perspiration is a factor, reliable automatic controls for reducing no-load voltage are recommended to reduce shock hazard.

## ARC WELDING

### VOLTAGE LIMITS

The following limits must not be exceeded:

<u>Type of Welder</u>	<u>Alternating Current (AC)</u>	<u>Direct Current (DC)</u>
Manual	80 Volts	100 Volts
Automatic <sup>1</sup>	100 Volts	100 Volts

<sup>1</sup> Machine or mechanized

12. Grounding

- Frame or case of the welding machine must be grounded, except engine-driven machines
- Conduits containing electrical conductors must not be used to complete a welding circuit
- Pipelines must not be used as a permanent part of a welding circuit, but may be used during construction, extension or repair if:
  - Current is not carried through threaded joints, flanged bolt joints or caulked joints
  - Special precautions are used to avoid sparking at connection of the work-lead cable

13. Operation and Maintenance

- Before starting operations, all connections to the machine must be checked
- Work lead must be firmly attached to work
- Magnetic work clamps must be free from metal particles on contact surfaces
- Coiled welding cable must be spread out before use to avoid overheating and damage to insulation
- Cables with splices within 10 feet of the holder must not be used.
- Welders should not coil or loop welding electrode cable around parts of their body
- Cables with damaged insulation or exposed bare conductors must be replaced
- Joining lengths of work and electrode cables must be done by connecting means specifically intended for that purpose; connecting means must have adequate insulation

D. Resistance Welding

1. Installation

- All equipment must be installed by a qualified electrician in conformance with Subpart S, Electrical

2. Spot and Seam Welding Machines

- All doors and access panels and control panels must be kept locked and interlocked to prevent access by unauthorized persons to live portions of the equipment
- All press welding operations, where there is a possibility of the operator's fingers being under the point of operation, must be effectively guarded by the use of a device such as:
  - Electric eye safety circuit
  - Two hand controls
  - Protection similar to that required for punch press
- Hazards of flying sparks must be, whenever practical, eliminated by installing a shield guard of safety glass or suitable fire-resistant plastic at the point of operation

- Additional shields or curtains must be installed as necessary to protect passing persons from flying sparks
- All foot switches must be guarded to prevent accidental operation of the machine
- Two or more safety emergency stop buttons must be provided on all special multispot welding machines, including 2-post and 4-post weld presses

3. Portable Welding Machines

- All portable welding guns, transformers and related equipment suspended from overhead structures, I-beams, trolleys, etc. must be equipped with safety chains or cables capable of supporting the total shock load in the event of failure of any component of the supporting system